DOCUMENT RESUME

ED 296 490	EC 210 254
AUTHOR	Bell, William G., Ed.; Ashford, Norman J., Ed.
TITLE	Proceedings of the International Conference on Mobility and Transport of Elderly and Handicapped Persons (3rd, Orlando, Florida, October 29-31, 1984). Final Report.
INSTITUTION	Department of Transportation, Washington, D.C.
REPORT NO	DOT-1-85-07
PUB DATE	Oct 84
NOTE	416p.; Produced by the Office of the Secretary, Technology Sharing Program.
PUB TYPE	Collected Works - Conference Proceedings (021) -- Reports - Descriptive (141)
EDRS PRICE	MF01/PC17 Plus Postage.
DESCRIPTORS	*Accessibility (for Disabled); Air Transportation; Area Studies; Cost Effectiveness; Foreign Countries; Human Services; Microcomputers; *Mobility Aids; *Older Adults; *Physical Disabilities; *Physical Mobility; Program Development; Program Evaluation; Public Policy; Technology; *Transportation

ABSTRACT

These conference proceedings contain the texts of 62 papers. The first 17 papers include 4 keynote presentations as well as reviews of: major developments in several countries (Brazil, Canada, Great Britain, Jordan, Netherlands, Sweden, United States) and Hong Kong; handicapped travelers' access to air transport; and application of microcomputer technology to specialized transport. The remaining 41 papers report on various aspects of the state of the art. A sampling of titles and authors includes: "Towards a Global Policy on Transportation for Elderly and for Handicapped Persons" (Lennie-Marie Tolliver); "The Importance of Mobility Opportunities for the Elderly and Handicapped" (Alfred Dellibovi); "Coping with the Handicapped Air Traveller" (J. Dunlop); "Study of Restricted Mobility Levels and Trip Characteristics of the Disabled in Japan" (Tetsuo Akiyama); "Spacial Design Technique for Users of Wheelchairs and Other Mobility Aids" (John Bails); "Evaluating the Benefits of Special Transport for Elderly and Disabled Persons" (S. Bowlby et al.); "Monitoring the Trials of a Prototype Taxi Accessible to Disabled People" (M. Hall et al.); and "Developing and Implementing Functional Eligibility Criteria for Users of Specialized Transportation Services" (Judith Hollander and Robert Works). (JDD)

****
* Reproductions supplied by EDRS are the best that can be made *
* from the original document. *
****

U.S. Department of Transportation

Third International Conference on Mobility and Transport of Elderly and Handicapped Persons

Conference Proceedings

ED296490

October 1984

U.S. DEPARTMENT OF EDUCATION
Office of Educational Research and Improvement
EDUCATIONAL RESOURCES INFORMATION CENTER (ERIC)
☑ This document has been reproduced as received from the person or organization originating it
☐ Minor changes have been made to improve reproduction quality
• Points of view or opinions stated in this document do not necessarily represent official OERI position or policy

EC210254

Third International Conference on Mobility and Transport of Elderly and Handicapped Persons

Conference Proceedings

Final Report
October 1984

Conference Coordinated by
Dr. William G. Bell
Center on Gerontology
Florida State University
Tallahassee, Florida 32306

Produced and Distributed by
Technology Sharing Program
Office of the Secretary of Transportation
Washington, D.C. 20590

DOT-I-85-07

TABLE OF CONTENTS

I. Introduction by the Editors

Introduction to this Volume, William G. Bell and Norman J. Ashford 1-1

II. Keynote Presentations

Towards a Global Policy on Transportation for Elderly and for Handicapped Persons, Lennie-Marie P. Tolliver 2-1

The Canadian Approach to the Transportation-Handicapped, Bruce Halliday 2-4

The Importance of Mobility Opportunities for the Elderly and Handicapped, Alfred Dellibovi 2-6

III. National Overviews

The Current Status of Specialized Transportation in Brazil, Eduardo Alcantara de Vasconcelos and Sergio Michel Sola 3-1

Transportation for the Disabled in Canada: An Overview, Claude Forcier 3-5

Transport for the Disabled in Hong Kong, John Collins 3-9

The Mobility and Transport of Handicapped Persons in Developing Countries: The Case of Jordan, Abdelgader 0. Elshabani 3-13

Developments in the Area of the Transportation of Handicapped Persons in the Netherlands: Some Sociopolitical, Financial and Technical Approaches, D.A. Vogelzang 3-16

Providing Access for the Disabled to Public Transport Facilities and Buildings-Role of the Swedish Board of Transport, Bengt Finnveden 3-21

The Role of the British Department of Transport in Public Transport for Disabled People, C.G.B. Mitchell and Ann Frye 3-23

The Direction of National Developments in Specialized Transportation in the United States, William G. Bell and Joseph S. Revis 3-37

IV. Air Transport and the Handicapped Traveller

Air Accessibility Standards: The Canadian Model, David Baker 4-1

Coping with the Handicapped Air Traveller, J. Dunlop 4-5

Provision for the Disabled: An Aircraft Manufacturer's Perspective, Werner Gronow 4-12

Airports and the Handicapped Traveller—A British Perspective, Alistair Matson 4-14

Available Research on Disabled and Elderly Air Passengers, Ellis Reida 4-19

V. Application of Microcomputer Technology to Specialized Transport

The Application of Commercially Available Software to Paratransit Management, Marc R. Cutler and Lawrence J. Harman 5-1

Computer Simulation Modeling: Applications for Transportation Policy Analysis, Barry L. Nazar and James E. Hayth 5-9

An Introduction to Utilization of Microcomputers by Specialized Transportation Providers, Robert E. Paaswell, Claire E. McKnight, and Joseph V. Depa 5-19

Microcomputer Applications in Smaller Paratransit Agencies, Nigel Hamer and Jean-Marc Rousseau 5-27

VI. Workshops: The State-of-the-Art

The British Community Bus Concept—Lessons from the Soar Valley Experiment, J. Abbiss, D. Gillingwater, J. Sutton, and D. Marshall 6-1

Study of Restricted Mobility Levels and Trip Characteristics of the Disabled in Japan, Tetsuo Akiyama 6-16

Underlying Factors in the Development of Demand Responsive Transport in Britain, J.M. Bailey 6-23

Spacial Design Technique for Users of Wheelchairs and Other Mobility Aids, John H. Bails 6-31

Auto-Ride—A Videotex-Based, Paratransit System of Low Cost, Door-to-Door, Transit Services, Robert W. Behnke and Malcolm McLeod 6-43

The Impact on Vehicle Routing of Various Operational Rules of a Transportation System for Handicapped Persons, Jean-Pierre Belisle, Francois Soumis, Serge Roy, Jacques Desrosiers, Yvan Dumas and Jean-Marc Rousseau 6-47

A Conjoint Analysis of the Preference for Service by Handicapped Persons, Julian Benjamin 6-52

Evaluating the Benefits of Special Transport for Elderly and Disabled Persons: This Case of Readibus, S.R. Bowlby, A.M. Kirby, and V. Swann 6-58

Cost Analysis Techniques for Transportation Systems Serving the Elderly, Jon E. Burkhardt, Sue F. Knapp, and Mark C. Wozny 6-63

Crash Protection of Children, the Elderly, and the Handicapped and the Design of Inflatable Compartmentalized Controlled Deformation Protective Systems for them, Carl C. Clark 6-68

Improving the Performance of Transportation to the Handicapped Through User-Side Subsidies: Calgary's Experience, David Colquhoun and Dan Bolger 6-75

Cost-Effective Data Collection Process to Support Transportation Planning for Transportation-Handicapped People, Daniel L. Dornan, David P. Middendorf, and Richard P. Steinmann 6-82

A Regional Reduced Fare Permit for the Elderly and Disabled, Barbara Dougherty and Edward McCormack 6-91

A Comparison of Five Exemplary Transportation Services for the Disabled, Carol T. Everett 6-96

The Evolution of Transportation Programs for the Disabled in Three Pennsylvania Cities, Michael Fix 6-102

A Non-Compensatory Approach to the Travel Behavior of the Elderly and Handicapped, Howard L. Gauthier and Bruno P. Parolin 6-110

Monitoring the Trials of a Prototype Taxi Accessible to Disabled People, M.S. Hall, D.T. Silcok, J. Haigh and D. Hofmann 6-117

A Human Factors Field Evaluation of SCAT, a Vehicle for Within-Terminal Transfer of the Elderly and Disabled, Ruth M. Heron and Uwe Rutenberg 6-127

Developing and Implementing Functional Eligibility Criteria for Users of Specialized Transportation Services, Judith G. Hollander and Robert M. Works 6-132

Identifying and Evaluating Service Alternatives for Elderly and Disabled Persons in Charlotte, North Carolina, Katherine Hooper, Mary McGee, and Joseph S. Revis ... 6-137

Estimating the Demand for Special Transport for Disabled People in Great Britain, Jean M. Hopkin 6-145

Development of an Evaluation Methodology for State Agencies Funding Elderly and Disabled Transportation Programs: A Coordinated Approach, Kenny Hosen 6-162

The Process of Successful Transportation Contracting: Case Studies and Recomendations, Mary Hough and Ann Zeltmann 6-167

Accidents of Elderly Pedestrians in Israel: Their Relation to Behaviour and Housing, Allan Katz, Alit Elgrishi, and Lily Guttmann 6-173

Vehicle Dispatching System for Specialized Transportation, Shinya Kikuchi 6-178
Safety and Long-Distance Transportation for the Disabled, Bhagirath Lall 6-186
A Model of Paratransit Dexand and Supply, David L. Lewis 6-191
Special Needs in Public Transportation in Canada: Some Survey Results, Mara Lee McLaren and Marion S. Fleming 6-198
Adaptations to Stage Carriage Buses for Disabled and Elderly Persons, P. Oxley and M. Benwell 6-207
Access to Standard Production Cars by Disabled and Elderly People, M.E. Page, J. Spicer, I.L. McClelland, C.G.B. Mitchell, R.J. Feeney, and J. James 6-216
Making Crossing Structures Accessible for Elderly and Handicapped Pedestrians, Richard A. Richter and John C. Fegan 6-221
Conceptual and Operational Problems in Surveying the Disabled, M.J. Sheridan 6-225
Public Transportation for the Elderly in Sweden: Technical and Behavioral Issues, Agneta Stahl 6-232
Canadian Development in Vehicle Technology for Transportation of the Physically Handicapped, Ling Suen and Peter J. Kaulback 6-239
Training the Transportation Handicapped to Use Public Transit, Cathleen E. Towner 6-245
Transport Usage by the Active Elderly Holding Free Travel Passes, P. Truelove 6-249
Multipurpose Vehicles as a Solution to the Need for Transportation of the Elderly and Handicapped in Small and Isolated Communities, Jim Wallace and John C. Rea 6-252
A History of the Section 504 Regulations, Erskine S. Walther, William Crown, Lalita Sen and Harold G. Willis 6-257
Effective Taxicab Transportation for the Disabled, Michel Wilson 6-262
Transit for the Transportation Disadvantaged in Mississippi, J. Fred Wise and J. William Rush 6-265
Vehicle Ownership and Driving Behaviour of Seniors in Canada, Robert A. Wolfe .. 6-271

VII. The Global Village

Transportation of Elderly and Handicapped Persons: The Right to Mobility in the Global Village, Janice J. Tait 7-1

1

Introduction by the Editors

Introduction to this Volume

Attendance at the Third International conference exhibited a marked expansion of participation when contrasted to the prior conference held in Cambridge, England in 1981. Whereas the second international conference attracted representation from six countries, by 1984 the countries represented rose to fourteen: Australia, Brazil, Canada, France, Hong Kong, Iran, Israel, Japan, Jordan, the Netherlands, Sweden, the United Kingdom, the United States and West Germany.

Some two hundred and seventy persons from these fourteen countries participated in the Third International Conference on Mobility and Transport for Elderly and Handicapped Persons, held October 29-31, 1984 in Orlando, Florida. As in the case of the two prior international conferences, the event was under the joint auspices of Florida State University (US), and Loughborough University of Technology (UK). Staff associated with the Center on Gerontology at Florida State University coordinated the 1984 conference.

Of those persons in attendance, about 75 percent came from the United States, about 15 percent from Canada, 5 percent from the United Kingdom and the remaining 5 percent from the other eleven countries. The US contingent, totalling about 205 persons came from thirty-seven states; the Canadian group of forty were drawn from six of Canada's ten provinces.

The sixty-two papers to follow can be classified according to five categories:

1) four are identified as keynote presentations;

2) eight are overviews of major developments in seven countries and Hong Kong;

3) five deal with air transport and handicapped travelers;

4) four address the technical area of micro-computer applications to specialized transport services; and

5) the remainder, some forty-one papers, report on various aspects of the state-of-the-art, based largely on research findings. As the reader enters the terrain of this potentially rich source of information on specialized transportation for the elderly and handicapped, a brief highlighting of recent significant developments may be appropriate.

Highlights

1. Policy emphasis.

The modal group of policy interest in most countries represented at the international conference is their respective physically handicapped population. The strong interest on the elderly (not necessarily with handicaps) along with disabled persons, evident in the United States, is not matched by other countries.

2. Scope of transportation system modification.

Sweden appears to have gone further than any other country in the modification of its transportation network to make its multiple elements accessible to the handicapped. The Swedish Board of Transport has executed mandatory regulations on accessibility affecting buses, trains, subway stations, and vessels operating on water, but does not yet include aircraft or airports. However, Sweden does require all freshly constructed buildings to be made accessible to the physically disabled.

3. Legal rights of the disabled.

Canada has taken far reaching steps in incorporating the legal rights of the disabled through two consitutional measures to take effect in mid-1985. The measures which are likely to be tested in the courts at a later date are: the Charter of Human Rights and Freedoms and the Canadian Human Rights Act. Both are expected to contribute to strengthening the Canadian Model of Accessibility cited in the paper by Baker in this volume.

4. Emergence of a new generation of London taxis.

In Britain where tradition is highly valued the traditional London cab is undergoing major re-design to be usable by wheelchair users, partially sighted patrons and the ambulant disabled. A prototype has been available for some time for testing purposes; full scale production has not as yet been initiated.

5. Improving inter-country air travel for the handicapped.

On an international level, there is discernable interest in the current differential status of accessibility standards among countries with a view towards altering existing multiple barriers that tend to inhibit inter-country travel of handicapped persons. New designs for cabin interiors, development of an on-board wheel chair, and other useful measures are being taken to respond to the growing market of handicapped travelers, as revealed in the papers prepared by the panel on air travel.

6. Interest in specialized transportation in developing countries.

While the predominant interest on the part of developing countries represented at this conference was on the handicapped, there is an apparent interest in mobility problems of all transportation dependent in their respective countries. Representation from underdeveloped countries at this international conference may be among the signficant signs that a process of exchange on specialized transportation developments likely to be beneficial to both developing and developed countries, lies immediately ahead.

Acknowledgements

To begin, a number of federal and state agencies from Canada and the United States were part of a financial consortium underwriting the conference budget: Transportation Development Center, Transport Canada; Urban Mass Transportation Administration, US Department of Transportation; US Administration on Aging; Bureau of Transit, Florida Department of Transportation; Aging and Adult Services Program Office, Florida Department of Health and Rehabilitative Services; and the International Exchange Center on Gerontology, at the University of South Florida.

The Transportation Research Board, National Research Council, was a co-operating member of the conference sponsorship group, but could not contribute funds.

There are a number of individuals to whom the international conference is indebted by reason of their professional or personal contribution. Federal policy of the US government prefers that federal officials not be identified by name in connection with their routine assignments. However, some federal officials will be cited in their role on committees.

The Conference Steering Committee: Stephen Blake, Dennis Cannon, Marion Fleming, Ira Laster, Robert Paaswell, Joseph S. Revis, Harold L. Sheppard, Peter Strengers, Ling Suen, Floyd Godfrey and Robert Wolfe.

Florida DOT: William W. Miller, Jr., Emmett Owens, David Duffy, JoAnn Hutchinson, Marion Hart; Florida D/HRS: John Stokesberry and John Lowther; International Exchange Center on Gerontology: Thelma Ruth Barber; UK, DOT, Transport and Road Research Laboratory: C.G.B. Mitchell.

The Conference Support Staff, particularily Suzanne Hunt of the Center on Gerontology at Florida State University who stepped into a difficult role at a critical stage of the conference, and Joan Grant, our project officer at the University's Center for Professional Development. Other staff who assisted included, from the Center on Gerontology: Flossie Smallwood and Judy Meyer; Center for Professional Development: Deidre Rockwell; and University of Technology, Loughborough, UK: Vivien Grove.

A cadre of secretaries at Florida State University, most allied with the Institute for Social Science Research, under the supervision of Babs Rousseau, typed and re-typed the manuscripts in this book: Mary Schneider, Barbara Hines, Jean Mitchell and Ann Fountain.

Finally, we acknowledge the financial, technical and personal assistance of the Office of Technology and Planning Assistance, Office of the Secretary, US DOT which made this publication possible.

We are appreciative too of the authors, many from a considerable distance from Florida who shared their findings and views in the papers you have before you.

We thank them all.

William G. Bell, Tallahassee, Florida, Editor
Norman J. Ashford, Loughborough, UK Co-Editor

9

2

Keynote Presentations

TOWARDS A GLOBAL POLICY ON TRANSPORTATION FOR ELDERLY AND FOR HANDICAPPED PERSONS

Lennie-Marie P. Tolliver

For those of you who have traveled from various parts of the globe, we welcome you to the United States of America. We commend you for recognizing the importance of examining and trying to improve your roles and relations with other countries, organizations, and citizens in developing and implementing transportation programs for older and handicapped persons. Experience has shown that countries with different political, economic and social systems and cultures, and who are at different stages of development have benefited from the sharing of problems, experiences and achievements and from solutions worked out jointly. Together, the varous countries represented here can continue to identify our respective concerns and problems in a concerted effort to improve and increase transportation services to older and handicapped individuals in a cost effective and creative manner.

It has been just over two years since I participated in the World Assembly on Aging in Vienna, Austria. That Assembly's recommendations for action, on behalf of older citizens who have lived 60 years or more, in the areas of Social Welfare and Family, and the expanded role of governments to improve cooperation in the exchange of technical and programmatic information are still very clear in my mind. Only within the last twenty years has the attention of national societies and the world community been drawn to the social, economic, political and scientific questions raised by the growth of aging persons on a massive scale.

Although many individuals throughout human history have lived into advanced stages of life, their numbers and proportion in the total world population were not high. The twentieth century, however, has witnesssed in many regions of the world the control of prenatal and infant mortality, a decline in birth rates, improvement in nutrition, improvements in basic health care and the control of many infectious diseases. This combination of factors has resulted in an increasing number and proportion of persons surviving into the advanced stages of life.

According to the United Nations' estimates, in 1950 there were approximately 200 million persons 60 years and over throughout the world. By 1975, their number had increased to 350 million. United Nations projections for the year 2000 indicate that the number will increase to 590 million, and by the year 2025 to over 1,100 million. This would constitute a 224 percent increase during the 50 years form 1975 to 2025. Within this same time period the world's population is expected to increase by 102 percent from 4.1 billion to 8.2 billion. Therefore, 41 years from now those individuals 60 years of age and older will represent almost 13.7 percent of the world's population This presents a challenge for us now and in the future. An aging world is upon us, whether we are prepared for it or not.

The growth of the world's aging population is an unmistakable demographic phenomenon with profound implications for the decades ahead. Rapidly expanding technologies and the evolution of social and institutional structures will have extensive impact on and implications for policies, programs, and services for older persons. The impact of these and other changes will affect all levels of society — not only policymakers, program planners, and service providers — but also our basic social institutions, including families and individuals who share responsibilities for the care and well-being of the elderly.

Social welfare programs funded by the U.S. Government encompass a broad range of services to older Americans and are consistent with the social welfare goals and recommendations of the 1982 Vienna International Plan of Action on Aging. These programs provide diverse community and social services including the support of senior centers, home health programs, legal services, education, nutrition services, transportation, employment, and volunteer opportunities. Current programmatic priorities for the elderly include assisting states and communities to reduce the incidence of functional disabilities; promoting public/private partnerships in addressing the needs of the aged; promoting increased labor force participation; facilitating access of the elderly to community-based care; encouraging the development of cost effective approaches to publicly financed social services; promoting intergenerational programming; and, targeting support to those elderly in greatest need. In addition to these factors, older Americans benefit from an extensive and diverse array of publicly and privately supported health programs and services which address their needs for both acute and chronic care. While some gaps and problems in coverage do exist, the vast majority of older Americans have access to the services they require.

The federal government of the United States has responded dramatically to our growing population of older persons by establishing and administering nearly 150 separate programs that serve older people. Nineteen years ago Congress passed the Older Americans Act and established the Administration on Aging (AOA) as the principal agency for carrying out the provisions of that Act. The AOA, as the agency is more often called, is housed administratively in the Department's Office of Human Development Services, and is empowered:

- To serve as the effective and visible advocate for the elderly within the Department of Health and Human Services, other agencies of government, and the private sector;
- To evaluate and coordinate programs related to older people and work with public agencies and private organization and indeed with groups such as you represent here — to improve the quality of life for older people;
- To provide community-based services which are targeted to those in greatest economic or social need; and
- To support education and training as well as demonstration and research projects designed to increase the knowledge of professionals and older individuals alike.

Older Americans today are healthier, better nourished and living longer than ever before in our Nation's history. Better personal health habits and life-styles, a more healthful environment, improved work-place safety, better nutrition and a general improvement in levels of income and education—all have contributed to improved well-being of our older citizens.

The health and general quality of life of older Americans have also been improved by the scientific and technological advances that are taking place in all sectors of society in our country. From computer assisted learning to artificial body parts, the lives of older Americans are being significantly affected by a partnership which includes academia, business, and departments and agencies of government ranging from the Department of Health and Human Services to the National Aeronautics and Space Administration. At the same time, the increasing cost of some of these technological advances and the unevenness of their benefits have prompted a re-examination of philosophies and policies surrounding their use, especially regarding health care.

Research continues on all fronts—the biomedical, behavioral, and social. We are investigating the cellular, molecular and other bases of change within aging populations, to name a few, such as: (1) the role of genetics in aging; (2) health behaviors and their impact on aging; (3) social environments influencing health and effective functioning in the middle and later years; and (4) visual and other sensory perceptual changes with age.

Even with the many advances made in recent years in our understanding of the aging process, improvements in our ability to intervene in potentially debilitating circumstances, and our ability to prolong life, there are many unknowns which continue to challenge us.

Specific projects, findings, and their implications cannot be cited here. However, our government has produced publications which summarize these findings and which are routinely made available to the international research community.

Transportation is the catalyst to facilitate access to many services and opportunities that have come to define the quality of life in our complex world. To the degree we achieve success in providing access —not just for survival — but to promote life with dignity and purpose for the world's elderly and handicapped, we will be contributing also to life with dignity for all older people.

The transportation problems of older and handicapped persons have been extensively documented over the last 10 years but it was not long ago that their mobility needs were imperfectly understood or even recognized. "Old Age" was, in essence, frequently perceived by the public and human services professionals alike to be synonomous with age 65 or older, and that meant isolation from daily social and economic activities. Our perceptions have broadened and cleared over the past several years, but we yet have a long way to travel before we can rest.

The mobility needs of these older persons has been seriously impaired for several reasons: a lack of adequate public and private transportation necessary to insure access to the goods and services they needed or desired; problems caused by insufficient income to own an automobile or an unwillingness to drive because of physical problems or limitations; or the location and design features of conventional mass transit. These factors are just a few of the many affecting the mobility of older and disabled persons. Programs designed to provide services and support to older and disabled Americans were constrained because they could not reach isolated persons in rural or urban areas. Most of the social programs of the "sixties" (including Older Americans Act programs) were put in place quickly and with little thought for accessibility by the elderly or handicapped since gasoline was cheap and plentiful then.

During the last decade, however, a wide range of programs concerned with the transportation problems of older Americans have emerged. Special legislation has been passed programs implemented, and a broader cross section of funding sources have been developed. There is no longer a problem of "awareness" in America; a flow of studies, reports, and demonstration projects have brought the issue before Congress, the executive branch, and the public.

There is now in place a substantial infrastructure capable of delivering significant volumes of transportation services. Our estimates indicate that somewhere between 3500 to 4200 transportat projects are currently being funded under Title IIIB supportive services of the Older Americans Act alone, and that estimate is likely to be on the low side. We also estimate that transportation providers are coordinating at least 800 million dollars in federal, state, and local funds to provide special transportation services to the elderly and handicapped. This estimate includes transportation projects for which the primary funding comes from such federal programs as Sections 5 and 16(b) (2) of the Urban Mass Transportation Act, and Titles XIX and XX of the Social Security Act — to mention but a few of the funding sources available for transportation. Although it has not been possible to estimate the total number of projects currently serving the elderly under all funding programs, it is quite evident that it is substantially higher than the 3500 to 4200 projects estimated and funded under Title III of the Older Americans Act.

It is clear that much progress has been made over the last decade in the way of providing transportation for older and handicapped persons. This progress has occurred under pressure from a variety of advocates for older and handicapped persons. These advocates include state and area agencies on aging, human service agencies and organizations, community leaders, older people and handicapped persons. Progress has taken the form of improvements to existing transportation facilities, initiation of new services, specialized services, favorable legislative changes at the federal and state levels, and clarification of existing federal regulations.

The joint action of aging and handicapped service providers and other social service agencies to improve transportation services, whether through cooperation between agencies, coordination of services, or consolidation of operations, has proved fruitful in improving transportation. To the extent that coordination can take place, the major objectives of coordination—reduction of capital expenditures, increased amount of service, improved use of resources, and improved provision of services—are beginning to establish themselves as good management practices in the delivery of transportation services to older individuals.

The years ahead will present both opportunity and danger for this international community. The opportunity is the opportunity to plan; to study in advance how we shall cope with profound demographic change; to shape our ideas and programs for a new era.

The danger is the danger of doing nothing, or too little, or too late. The danger of ignoring approaching change until it sweeps over us; the danger of making drastic changes all at once, instead of careful, rational changes over time.

As we reflect on the ever increasing number of older world citizens—already totaling some 400 million—there is reason to be optimistic. Opportunities will be greater for older people for several reason. They will be healthier and live longer. They will be better educated. And they will be more secure economically. The increasing awareness I spoke of at the outset will break down some of the myths and stereotypes about aging that still prevail in the world.

In summary, my remarks today would suggest that a world policy on transportation for older and handicapped persons must be future-oriented; that to be effective, it must take into account the future growth and characteristics of our aging populations As I have indicated, transportation is a means not an end, but a vital means to gain access to health and welfare programs, and to personal dignity that millions of older and handicapped individuals are entitled to throughout the world. This international conference is indeed another opportunity for us to sharpen our perceptions, update our knowledge on current policies and state of-the-art in specialized transportation. As we go about our business over the next few days, let us continue the open dialogue that has resulted in a clearer understanding about our mutual problems. In this way, we can together develop programs that will constitute an agenda of priorities on how best to provide a more decent life for these persons for whom we have concern, and assure all our citizens years of promise and fulfillment. The United States of America is committed to the cooperative development of a world policy on aging that is forward looking. We look forward to learning the results of your deliberations.

At the time this presentation was made, Lennie-Marie P. Tolliver was US Commissioner on Aging, Washington, D.C. 20201.

THE CANADIAN APPROACH TO THE TRANSPORTATION—HANDICAPPED

Bruce Halliday

Canada, as an industrialized country, is only now coming to grips with many complex issues which are necessary to give disabled and elderly persons an equal level of accessibility to the many services and institutions which Canadians normally take for granted.

Indeed, in recent years, there has been a gradual improvement in the provision of goods and services to disabled and elderly consumers in our society. Nonetheless, there remain a great many unnecessary barriers that inhibit disabled and elderly persons from participating as fully as possible.

The first major national initiative, to investigate the concerns of disabled persons and organizations representing them, occurred in 1980 when the Special Parliamentary Committee on the Disabled and Handicapped was created. It was my privilege to be a member of that Committee for its full life.

Its major report, entitled "Obstacles", published in February, 1981, which was the International Year of Disabled Persons, identified wide gaps in the provision of goods and services to handicapped and disabled Canadians. The report included one hundred and thirty specific recommendations calling for legislative, fiscal and administrative action by the federal government, and outlined practical means to implement them.

The government was then called to act upon these recommendations. Major government departments, including Transport Canada and the Canadian Transport Commission, as well as non governmental organizations, prepared responses.

The report recommended that the Canadian Human Rights Act be extended to protect disabled persons from discrimination in the provision of goods, services, facilities and accomodations, as well as employment. On March 30, 1983, Parliament gave assent to a bill to amend the Act in accordance with that recommendation.

On April 17, 1983, Canada, as part of a new constitution received a Charter of Rights and Freedoms containing an "equality rights" provision in Section 15 which specifically prohibits discrimination on the basis of "mental or physical disability".

However, the Charter of Rights and Freedoms goes beyond the legislative and political realities of human rights, and addresses social, economic and cultural rights. This "new generation" of rights is a result of Canadians realizing, more and more, that political and legal rights confer the necessary framework from which other rights evolve, responding to perceived needs and new realities.

The Charter and the Canadian Human Rights Act provide the legislative tools with which government must act. In addition to this, in 1982, the General Assembly of the United Nations adopted the World Program of Action Concerning Disabled Persons, and declared 1982—1992 the United Nations Decade of Disabled Persons. Member states must submit a progress report at mid-decade on the progress being made to implement the World Program's principles and objectives. The Minister's Secretariat holds the responsibility of coordinating a Canadian Action Plan and reporting back to the U.N. on progress.

In developing a Canadian Action Plan, the Secretariat is engaged in a consultation process with several key players, including the federal government, governments of Canada's ten provinces and two territories, nongovernmental organizations, and the private sector.

To this end, the first-ever conference of federal and provincial ministers responsible for the status of disabled persons is scheduled to be held early in 1985. Development of a Canadian Action Plan will be a focal point, as well as the identification of key issues which require cooperation between the two levels of government.

As a major department in the federal government with a direct jurisdiction over the air and rail modes, as well as east coast ferry service, the "Roadcruiser" bus service in Newfoundland, and interprovincial bus services, Transport Canada, along with the Canadian Transport Commission, has had a major role to play with respect to reviewing tariffs and other regulations of travel to ensure that they comply with the Charter of Rights and Freedoms and the Canadian Human Rights Act.

In February, 1979, the Advisory Committee on Transportation of the Handicapped was created, with representatives from the federal government and various organizations representing disabled and elderly persons. One of the Advisory Committee's achievements was the development of a comprehensive Policy on Transportation of Disabled Persons.

Transport Canada is examining closely the specific problems within each mode of transportation in order to develop standards. Standards are necessary because safety, technology and economics, as well as basic dignity, must be considered in determining the extent to which disabled persons can be accommodated on each mode. As each mode is different, a unique set of standards must be created for each. This, as implied, involves going over every aspect of travel and determining a level of "reasonable accommodation" that is acceptable to the travelling disabled public, the carriers, unions and regulatory bodies. With respect to the air mode, Transport Canada is currently investigating the operational feasibility of the concept of "self-determination of self-reliance". Disabled persons contend that they are the best judges of their own abilities to handle situations including evaluation of the aircraft. Limitation of access should be controlled and involve strict criteria. Airlines in Canada now normally accept the individual's own determination.

Consistency and the even application of rules is another priority. On all modes, but especially the air mode, disabled passengers have been at the mercy of flight crew and ground personnel who must interpret the rules of travel. The development of standards will be expected to alleviate these problems.

International air travel is now becoming more accessible, thanks to a set of guidelines developed by the International Air Transport Association. Although these guidelines are voluntary, it is hoped that all countries will see the necessity of having a consistent set of rules for disabled air travellers. There have been complaints that rules are individually applied. To resolve this, but, in particular, the issue of self-reliance, it has been recommended that the International Civil Aviation Organizations (ICAO) investigate the possibility of developing an International Convention on accessibility for the transportation of disabled persons, to be presented to the Economic and Cultural Council (a UN body) by December 1986.

Important as air travel is for many people,. the great bulk of disabled people cannot afford the luxury of long trips for pleasure or business. They do, however, have a pressing need for transportation to get them downtown for shopping or social functions. While paratransit facilities provide such a service to varying degrees, there are large elements of the disabled population who do not live in large metropolitan areas, and who remain relatively under-serviced. These inequities in transportation must be addressed.

As already indicated, there is a prevailing interest in air travel, but we must not forget the importance of rail and bus travel in many countries, and the need that exists to make these modes of travel more accessible to disabled people.

One area which will need close national and internation cooperation is the area of global reciprocity in access to paratransit services. Elderly and handicapped persons in major Canadian cities have access to paratransit services which offer door-to-door service. If the disabled or elderly person travels—whether for business or pleasure—that person would not have the same access to different public transit systems which an able-bodied person would have. Central to this issue is the "separate but equal" status of paratransit services which often turn out to be not so equal. The principles of equalization of opportunity and full participation—central to the World Plan of Action Concerning Disabled Persons—would appear to necessitate the same access to paratransit services as are now enjoyed by able bodied persons to regular transit services.

Obviously, I have been able to touch only briefly on just a few issues which currently plague international as well as national travel by elderly and handicapped persons. Transport Canada has been working hard, along with the Canadian Transport Commission, and disabled people themselves, to provide basic access to transportation services within federal jurisdiction, and to facilitate cooperation where there is a split jurisdiction.

Also, Transport Canada, through its Montreal based Transportation Development Centre, has been involved in the research of new technologies which could be applied to transportation services and which would assure that disabled persons, regardless of disability, enjoy the same level of comfort as able-bodied persons have enjoyed. Examples of new technologies might be as simple as flashing lights at boarding gates, so a deaf person would know when to line up, or the production of tactile maps to familiarize blind persons with the layout of the airport.

All of this activity within a single government department is indicative of the work and progress elsewhere within the Canadian government to ensure that goods and services are made available to persons with disabilities.

As a concluding note, international conferences such as this one, provide an excellent forum to discuss emerging policies and issues. The Fourth International Conference on Transport and Mobility of Disabled and Elderly Persons will be held in Vancouver, Canada, in July 1986 in conjunction with Expo '86—a world fair which focuses on new transportation technologies. On behalf of the Secretary of State, we extend to all of you here an invitation to attend this next international conference and see first-hand the progress which has been made in Canada and elsewhere.

Bruce Halliday, MD is a Member of the Canadian Parliament and presented these remarks on behalf of the Honorable Walter McLean, P.C., M.P. Secretary of State for Canada and Minister Responsible for the Status of Disabled Persons.

THE IMPORTANCE OF MOBILITY OPPORTUNITIES FOR THE ELDERLY AND HANDICAPPED

Alfred A. Dellibovi

Transit is a service that has a major impact on people in virtually every facet of American life, and it is encouraging to see the extent of support that exists for making this man-made resource more available to those individuals who may rely on it most: the physically disabled and the older members of our society. I am also pleased to note that this issue commands the particular attention of the U.S. Secretary of Transportation, Elizabeth Dole, on whose behalf I appear before you at this international conference.

Last year, the Department of Transportation published a notice of proposed rulemaking that was designed to produce for disabled persons greater access to local mass transit services. Under the provisions of that proposal, transit authorities receiving federal funds would be required to make at least half of their peak-hour bus fleet accessible to disabled persons, provide paratransit or special services for the handicapped, or offer some combination of those options. We feel certain that with the concerted efforts of UMTA and the various transit authorities working together, we will be able to deliver these services in a manner that satisfies the needs of our disabled citizens.

In the Reagan Administration it is a major goal of the Department of Transportation to ensure that the mobility of older Americans and handicapped citizens is enhanced by the improvement of both public and specialized transportation systems in urban and rural localities alike.

By increasing the accessibility of these services, we directly affect the extent to which the members of these particular groups can participate in the countless activities that typify the American lifestyle. Accessible transit can bring them to school, to work, to medical care and to shop; it can bring our handicapped and our senior citizens to self sufficiency. And it can also bring them to recreation and just plain fun. The movie trip many Americans take for granted can be a special treat for a transportation dependent citizen.

This objective is a challange that we welcome. We feel certain we will continue to develop tools to increase our effectiveness, and that equal accessibility can one day become a reality.

Section 16 of the Urban Mass Transportation Act declares it to be a national policy that handicapped and elderly persons have the same right to the use of mass transit as any other individuals.

In the Reagan Administration we have attempted to implement this policy all over America through the practical application of the section 16(b)(2) program. According to this plan, UMTA's general capital assistance programs are supplemented by the funding of transportation projects that are exclusively for the benefit of the elderly and handicapped in all areas: urbanized, small urban, and rural. We firmly believe that mobility is just as important to rural Americans as it is to urban Americans.

The elderly and handicapped members of our society have needs that are special in many respects. In addition to the particular necessities involved with guaranteeing their mobility, many of them require health care and supportive service to which they must have access. Often, due to the low or fixed incomes of these individuals, securing personal transportation that is adequate to fulfill their needs is not now feasible. This is one reason why the accessibility of public transit systems is so essential.

Some years ago, the U.S. Administration on Aging funded a study of transportation for older Americans in which over 3,000 special transportation projects in the United States serving the needs of the elderly were identified. The findings of this study were revealing. They indicated that many of these projects were poorly planned, inadequately funded, fragmented, and often duplicative in nature.

UMTA and AoA have made every effort to contribute to the achievement of these objectives. We will continue to make section 16(b)(2) funding available to eligible nonprofit organizations in both urbanized and nonurbanized areas, in order to meet these specialized needs.

UMTA and AoA entered an agreement in July of 1983, which committed the two agencies to working together to accomplish the following:

- Increase the mobility of older Americans;
- Coordinate public mass transportation facilities and services with special transportation services for the elderly and handicapped;
- Pool health and social service program resources available to states and local authorities so their impact is maximized.

And I am happy to tell you that Secretary of Transportation, Elizabeth Dole, announced that for 1985, over $26 million has been dedicated to assist with Section 16(b)(2) projects, and another $71.8 million has been designated for Section 18 rural transit programs, a portion of which will benefit elderly and handicapped services. Through this funding, we can make possible further improvements in the standard of accessibility to public transit, in addition to generating more specialized transportation services that deal specifically with the mobility problems of the physically disabled.

It is important to realize that while Secretary Dole's entire administration is determined to expand and improve the specialized transportation services currently availble to the physically restricted members of our population, we cannot do the job alone. We cannot stress too strongly the vital role that the private sector must play in the provision of transportation service. Private sector opportunities to improve mobility include making buildings, offices, stores and shopping centers accessible. The private sector can also be critical in developing technologies to provide mobility, lifts that work and can be kept working, vehicles that are efficient, easy to maintain, and cost-effective to operate.

We need the support of the private community if we are to ensure that the specific requirements of all the people are met. We must be kept informed of what systems are working and what approaches are not successful. Only when we are armed with the necessary data can we guarantee that special transit needs are being properly served.

The Reagan Administration is well aware that determining how best to meet the exceptional transportation needs of the physically restricted is a complex and controversial issue. We also recognize that there exists a myriad of opinions on how best to improve transit services in order to meet these needs. The fact that this international conference has sparked such great interest shows that the solution to this problem is as elusive abroad as it is here in the United States.

Exchange is one benefit of this conference — to determine the course of action we should take, we have studied the means by which cities across the nation provide mass transit services to their disabled users. And we have read our mail and listened to whose who are transportation disabled and those who provide transportation.

We have discovered a variety of approaches: one city may make its buses accessible to disabled persons, another may operate demand-responsive paratransit systems, while still another may coordinate the services of private and non-profit service providers.

We are confident that whatever the approach taken, we have the resources to meet our responsibilities to our disabled citizens. We can do it by working together, by planning together, and by putting our skills to use in new and innovative ways.

In the United States this is a time when the nation's economy is causing many experts to reevaluate their projections and reprogram their computers. Families and businesses alike are once again capable of planning for the future, secure in the knowledge that our economy is healthy, perhaps stronger than it has been in two decades.

Transportation is sharing in this new economic prosperity, and is in fact responsible for some of it. In turn, as you are no doubt aware, we are investing more heavily in the infrastructure that is so vital to our transportation industries and our personal autonomy

It is essential to understand, however, that projects geared only to general improvements in the transportation system across this land leave out a significant percentage of the population.

The child who is incapable of boarding a bus because of confinement to a wheelchair; the elderly man or woman who cannot walk the several blocks from home to the nearest subway station, or can't get down to the platform if he does make it to the station; or the retired individual on a fixed income, whose budget does not allow for transit fares at the usual rate; all of these people have special transportation needs, and they are entitled to personal mobility.

Clearly, we are making progress in our commitment to bring transit services to all sectors of the population. Our interaction with the Administration on Aging, local transit authorities, and private non-profit providers has produced results for accommodation of the elderly and handicapped citizens throughout the country.

The work is not over, but it is important to realize that we are currently riding an upward trend. If we can continue on the path that has been laid out by legislation such as 16(b)(2), we are certain to attain even greater accessibility in the very near future.

This conference is a good example of the kind of effort that will light a candle. But one candle is not enough. The challenge for those of us here is to capture the light of this conference and bring it home to our communities. The exchange of ideas here is not one candle but many. If each of us can take one of those ideas back to our homes and develop that concept into mobility for one person who is home bound today then we will have been successful.

Alfred A. Dellibovi, Deputy Administrator, Urban Mass Transportation Administration, Washington, D.C. 20590.

3

National Overviews

THE CURRENT STATUS OF SPECIALIZED TRANSPORTATION IN BRAZIL

Eduardo Alcantara de Vasconcelos
and
Sergio Michel Sola

Introduction

Specialized transportation, among other definitions, can be described as transportation designed for elderly, handicapped, and low income people. In Brazil, specialized transportation is designed basically for low income people. Due to the social and economic characteristics of the country, Brazil can be considered a third world country, by reason of an extreme social inequity and a complex pattern of capitalistic development.

This paper deals with real and projected experiences with specialized transportation in Brazil , from an overall view to reflect the state of the art. Among many cases, we selected those that can be considered representative of this kind of transport in the country, according to its social and economic conditions. This report deals with six basic categories of transportation disadvantaged: (a) rural workers, (b) rural children, (c) low income urban workers, (d) unemployed, (e) elderly, and (f) handicapped.

Specialized transportation for rural workers is designed to bring agricultural workers to plantation sites every morning and bring them back to the city at the end of the day. Specialized transportation for rural children refers to school transportation in rural areas of the State of Sao Paulo, which collects children and takes them to available city schools. Specialized transportation for low income urban workers refers to special programs for those who receive very low salaries-less than $180 U.S. a month (equal to 3 minimum Brazilian salaries). Specialized transportation for the unemployed is designed to help alleviate the impact of the country's economic crisis by giving special assistance to the unemployed to travel and look for new jobs. Specialized transportation for the elderly relates to the practice in Brazilian cities, especially in Sao Paulo where 200,000 people over 65 years old have already received a free travel card for urban buses. Finally, specialized transportatio for the handicapped serves handicapped people treated at medical institutions or other public facilities.

Rural Workers

Specialized transportation for rural workers provides transport of workers from cities to plantation sites in agricultural regions of the country. This origin-destination pattern reflects the recent type of capitalistic development of Brazilian countryside that has shifted the residence of peasants to the nearest cities. In Sao Paulo, for example, the rural population dropped from 37 percent in 1960 to 20 percent in 1970 and to 11 percent in 1980.[1] Despite its adaptation to the actual economic conditions of the country, specialized transportation is a poor service in terms of safety and comfort. In Brazil rural workers who are transported are called "cold meal" workers because they eat a cold lunch brought from home to the sites. These are very low income workers, often illiterate, living in the city suburbs, forced to change their work place constantly and even survive without a job for several months of the year. According to a study made by Mello, 70 percent were illiterate, and almost all the families earned less than the absolute minimum to subsist.[2] According to a Secretary of Agriculture study, there were in 1980 in the State of Sao Paulo approximately 400,000 cold meal workers.[3] As of mid-1984, with the deepening economic crisis and the general decline in the income of the labor force, one estimate suggests this population to be at least 700,000, working mainly on sugar cane, coffee, orange, and cotton plantations.

The vehicles used in almost all the cases are diesel trucks with some modifications in order to carry people. According to a federal law passed in 1968, the modified truck has to have (a) a cover, (b) fixed seats, and (c) wooden or rope protection at the sides of the vehicle. It may carry no more than 45 workers. If these conditions are met, the truck receives a temporary license for transportation purposes.

The federal rules tend to be ignored. There are small and even large trucks without the prescribed modifications or with poor protection for passengers, and some carry up to 80-100 workers. Accidents are frequent; the worst ones involve crowded trucks traveling at high speeds with workers' tools in the same part of the vehicle carring passengers. Borges found a 6.82 rate of victims per accident.[4]

---

[1] Instituto Brasileiro de Geografia e Estatisticas—Anuario Estatistic do Brasil—1982.

[2] Mello, Maria Conceicao D/Incao—"0 Boia-Fria: Acumulacao e Miseria", Editora Vozes, Petropolis 1976.

[3] Secretaria de Estado da Agricultura—Estatisticas das Divisoes Regionais de Agricultura, Sao Paulo 1984.

[4] Borges, Eduardo Faria, Seguranca de Transito, Departamento de Estradas de Rodagem, Sao Paulo 1983.

The transportation contract is between the farmer or employer and the driver. The driver is the "agent" who brings the workers to the farmer; frequently the driver is a part-time worker too or a job supervisor. Transport is free; that is, there is no out-of-pocket expense on the part of the worker. There is no special training for drivers who need only "professional" driver's license in order to drive a bus or truck. The authorization to transport passengers is given on a temporary basis when the driver and the truck have been approved by the local traffic authority.

Farmers and employers do not want to pay higher fees for a better transportation service, but workers are beginning to demand change. At the beginning of 1984, a huge strike in Guariba, State of Sao Paulo, for higher salaries for part-time sugar cane workers, led to new contracts where the question of better transportation was also considered. There were demands for buses or for well equipped trucks, with physical separation between passengers and work tools (in case of an accident, tools are a hazard). New trucks are being tested, some with steel cabins, bus-like seats and windows, a special place for tools, and also for water, milk, and hot meals. The provision of hot meals on buses is said to increase worker productivity. At the federal level a new regulation is being studied, but its implementation will depend on many factors such as the political power of the cold meal workers to demand change, opposition by the employers, and the behavior of the national economy.

Rural School Transportation in Sao Paulo

The state has 12, 000 basic schools in rural areas offering the first four grades for some 300,000 children, with the remaining four years being offered only in urban areas. Due to the lack of transportation between rural areas and the nearest cities, as well as the social and economic characteristics of the rural population, a major proportion of the children who complete the fourth grade are unable to reach the cities and therefore do not complete the full regular minimum school period. In addition, teachers in rural schools receive no financial support to cover the cost of transportation and sometimes spend 20 percent to 30 percent of their salaries on transportation. As the rural roads are precarious, teachers encounter difficulty in getting to schools during the rainy season; it is very common to have a 2-3 day week instead of a normal 5 day week of classes by reason of inclement weather.

Presently, the State of Sao Paulo has a statewide school transportation program with several important basic characteristics. The first is that the program is financial and not technical; that is, the state pays part of the costs to municipal authorities, but provides no technical guidelines about the transport service with the exception of vehicles and driver guidelines. The driver has to be 21 years of age or over, and have a professional license. The vehicle has to carry the inscription "school" in black letters on a yellow background, and have a speedometer and individual seat belts. With respect to safety procedures, there is no special training for drivers or children. The second important characteristic is that financial support is limited to the first educational level (first eight years) and to children who live in areas which have no schools at the first level. The third is that the financial support is insufficient to cover the actual costs, which frequestly deters municipal authorities from providing the specialized transportation.

Every city interested in participating in the program has to send to the State Educational Authorities a plan regarding the transportation that it plans to provide. The plan must forecast the number and school grades of the children carried, description of the service to be provided whether by contract with a regular transportation enterprise or individual or use of its own vehicles.

During the period 1981-1983, 70 percent of the cities in the state requested financial support, for about 75,000 students to be transported. Financial support in 1983, for instance, covered only 27 percent of the costs for the cities, an amount roughly of $20 (U.S.) per child per year. It is observed that the cities found a way to cover the rest of the costs.

Vehicles used for special transportation purposes include:

Small vehicle: Volkswagen "kombi," which carry 9 adults (including the driver) and by law is allowed to carry up to 15 children. It is by far the most used, and may be called the "Brazilian School Bus;"

Small bus: there are four basic types of mini bus carrying from 15 to 28 children, utilizing diesel, gasoline, or alcohol for fuel;

Normal bus: The standard bus, diesel powered that can carry up to 36 children.

It should be noted, when there is a regular bus line operating in rural areas, the local government may give a free card to students at the first educational level, paying the fare directly to the operator. Sometimes the operator is required to subsidize 50 percent of the fares.

Urban Low Income Worker

The increasing weight of the expense of public transportation on the family budget, together with the general lowering of the mean income due to the recent economic crisis, is forcing transportation authorities to consider special programs to alleviate the problem, especially for low income workers who constitute the majority of the population. In the city of Sao Paulo, for example, 54 percent of the labor force are in the range of 1-3 minimum salaries per month, equal roughly to a range of $60 (U.S.) to $80 (U.S.) as of May, 1975.[5]

According to the minimum wage law of 1940, transportat should account for 7 percent of a typical worker's budget, but this figure has been surpassed dramatically. If it is accepted that at least two trips per day are necessary during a 30 day period, to cover both work and recreational destinations, the percentage of expenditure for transportation climbs to 11.2 percent of the minimum wage in 1970 and to 14.4 percent as of May, 1984. This statistic does not take into consideration workers who have to make four or more trips per day to other destinations. Obviously, there is a clear strain between the rising costs of transportation and the low level of worker's income.

The first new approach to be implementd was in Salvador, State of Bahia, in 1982. After a sharp increase in costs of bus tickets due to the need to cover rising costs and inflation, there was a huge protest by the population, burning of dozens of buses, and street battles with police. The government responded by restoring the prior fares and creating a half-fare for all users of urban lines between the hours of 4AM and 6AM. These changes contributed to an increasing deficit, since the government paid the bus companies the differences between fare box income and actual costs. As the financial situation worsened, at the beginning of 1983, transportation authorities decided to change the law again. The fare system was updated, the half-fare from 4AM to 6AM was maintained and other operational measures introduced, such as the extension of the falf-fare to all students all day on special lines, as well as free tickets for the elderly.

A second example found in the city of Campinas, State of Sao Paulo, was introduced in 1983. The program gives a 40 percent discount on urban bus tickets to workers who receive 1 or 2 minimum salaries per month ($120 (U.S.), May 1984. The approved candidate receives an identity card with a stack of vouchers, each corresponding to one month. With these slips the workers exchange the month's slips plus 60 percent of fares, and receives 50 bus tickets. Campinas has 1 million inhabitants and the program serves 70,000 workers who account for roughly 20 percent of daily bus trips.

A third example, not yet implemented due to operational and financial problems, is being studied by local transportation authorities in Sao Paulo. With 6 million bus trips per day made by workers, half of the total covering all modes: subway, suburban trains, taxis, and private cars, instituting special tickets for low income workers would be a complex undertaking. There are 9,000 buses operated by one municipal and 38 private companies with 650 routes. There are many bus lines that feed the subway and the suburbs, each with different fares. Besides this, there are problems related to the program itself, such as the logistics of registering people and distributing the tickets, the possibility of falsification of documents and the impact on system revenue. In sum, there are a lot of complex problems that have to be considered before the program can be implemented.

Unemployed Workers

Specialized transportation for the unemployed is being reviewed since unemployed people in Brazil receive no financial support from the government with the exception of monthly benefits accumulated during the work period. On the average, these benefits are enough to sustain the worker for two to three months after dismissal. This, together with the economic crisis, makes the situation critical. In 1984, in the Sao Paulo metropolitan region alone there were an estimated 1 million unemployed without finances and therefore dependent on family and community help.

The first example of a successful demonstration program for the unemployed comes from the city of Diadema, with 300,000 inhabitants, part of the Sao Paulo metropolitan region. A system was introduced that allows the unemployed to travel during the off-peak periods only, 5AM to 6AM, 9AM to 6PM, and after 8PM. The system provides 50 free passes per month to workers unemployed for more than 6 months but less than 2 years. The passes must be renewed every month. There are presently 8,000 unemployed using the system. A second program was adopted in Campinas, State of Sao Paulo. There the approved candidate, depending on one's economic condition, is eligible for 20 or 40 free bus tickets monthly. The only limitation is that the condidate has to be unemployed for at least three months when he applies for the tickets, up to a maximum of 24 months. The user has to return every two months to the issuing office to receive another stack of tickets and prove he is still unemployed. The project is still being evaluated but, like the low income workers' program, the distribution of tickets to the unemployed was found to be extremely complex, due to similar operational problems such as how to distinguish the unemployed from the underemployed. Some measures have been adopted, like limitation of the monthly benefit, the creation of a process to avoid falsification of documents and exclusion of the underemployed; however, there are practical difficulties of how to cope with these complexities. Transportation authorities are waiting for the right political atmosphere to review a final plan which will involve community representatives.

Elderly

The city of Sao Paulo has created a program to provide free urban bus transport to all people 65 years of age and over. The program, initiated in February 1984, has distributed about 200,000 cards, out of an estimated total of 350,000 people over 65 according to the 1980 census. The card allows the elderly to travel by bus any time, any day; it contains general information such as name, address, national identity number, and photograph of the person.

---

[5] Fundacao Sistema Estadual de Analise de Dados, Anuario Estatistico do Esta do de Sao Paulo—1982, Sao Paulo 1983.

To travel, the older person has to enter the bus through the front door, after waiting for the regular passengers to disembark (in Brazil, people board the bus through the back door and exit through the front), and show the special card to the driver.

The Municipal Transportation Company undertook an opinion poll of the elderly regarding the system.[6] A sample of 400 people was selected and basic findings showed that (a) 98 percent of the elderly approved the system, (b) 72 percent did not increase the number of trips because of the card, and (c) shopping and leisure trips account for 40 percent of the total trips. Similar systems are being adopted in other cities in Brazil: Rio Claro and Diadema (State of Sao Paulo) and Salvador (State of Bahia).

Handicapped

Transportation for the handicapped is still in the early stages of development in Brazil. There are some studies underway on legal and technical aspects of the issue but few projects are in operation. The possibility of access to public buildings is guaranteed to handicapped people by a 1978 amendment to the federal constitution. Nevertheless, there is a big gap between the law and its application. For example, very few public buildings and facilities are adapted to provide access for the handicapped. Recently the Companhia de Engenharia de Trafego (CET), among several public private institutions, under the leadership of the National Association for Technical Standards, finished a study on adapting public buildings and facilities for the handicapped. A similar study is underway on retrofitting public transportation equipment to meet the needs of the handicapped.

The most advanced experiment is found in Sao Paulo where the CET prepared three routes linking some associations of handicapped people to specific destinations such as parks and sports facilities.[7] The project included the development of signs and devices to improve the mobility of the handicapped. The international symbol of access was introduced to alert travelers to the proximity of road crossings for handicapped and blind people, and to identify special parking places for the handicapped.

The project included development of a series of educational signs to alert car drivers that they are entering a special traffic area. A sound signal was also developed for blind people, with two tones, one for green light and the other for red flashing light ("don't cross"). The project consisted also of the elimination or repositioning of sidewalk obstacles (telephone booths, posts), the installation of signs, the construction of ramps and lowered curbs, and training of the handicapped and specialized personnel from their associations. In Sao Paulo the subway company has been training its personnel to help the handicapped. In 1981 the Companhia Municipal de Transportes Coletivos (CMTC) established a special bus for handicapped people, with a chair lift and special stairs, on a 11 km line that links the handicapped to offices of the Association of Handicapped People. The city of Santos, State of Sao Paulo, has lowered curbs and installed advisory signs on selected avenues, to provide access by the physically handicapped. Finally, in Rio de Janeiro, there are special parking signs for the handicapped on the beaches.

Eduardo Alcantara de Vasconcelos, Technical Advisor, Company of Traffic Engineers, Sao Paulo, Brazil.

Sergio Michel Sola, Company of Traffic Engineers, Sao Paolo, Brazil.

---

[6] Companhia Municipal de Transportes Coletivos, Passe de Onibus para Idosos, Sao Paulo 1983.

[7] Companhia de Engenharia de Trafego—Pilot Project for the Physically and Visually Handicapped Persons, Boletim Tecnico no 24, Sao Paulo 1981.

22

TRANSPORTATION FOR THE DISABLED IN CANADA: AN OVERVIEW

Claude Forcier

Introduction

For those who are not familiar with Canada, let me provide a brief overview of the country.

Canada, with land space larger than the United States and a population of one-tenth its size, is composed of ten provinces and two Territories. Only 0.3 percent of the Canadian population lives in those Territories which account for 41 percent of the total land area. In the provinces, population per square mile varies from 3.89 in Newfoundland to 54.51 in Prince Edward Island while the overall provincial population goes from 118,229 in Prince Edward Island to over 8.5 million in Ontario.

While we are similar in many ways to our friends in the United States, we are different in many respects. And these differences manifest themselves in many ways, including our approach to mobility for the disabled.

I will not make any reference to the elderly, because in transportation terms we do not discriminate on the basis of age in Canada. Disabled citizens of all age can avail themselves of the special services offered. By the same token, able citizens of all ages, including the elderly, are expected to ride the regular transit systems. Age in itself is, therefore, not an eligibility criterion in special transit.

Background

As representative of the Canadian Urban Transit Association, I will be addressing the topic of mobility for the disabled in urban areas. My colleagues at this conference, representing other Canadian agencies, will probably address aspects of the nonurban situation.

In Canada, responsibility for urban transportation has been assigned to the provincial governments. This provincial responsibility is then delegated to the municipalities, with some strings attached. Accordingly, most of the initiatives and actions in urban transportation come from provincial and municipal governments. This is not to say that our national government is disinterested; it participates through research and development projects, rehabilitation programs, and various other activities. Because of this lack of a strong federal presence in urban transportation, the Canadian Urban Transit Association (CUTA) provides the only national forum where issues of urban mobility can be addressed.

Canada has a population of slightly over 25 million people. Surveys have shown that approximately one million suffer from some form of physical, visual or mental impairments which limit their mobility. The physical handicaps range from persons with severe arthritis to quadriplegics who are confined to wheelchairs or perhaps to their beds. It is expected that this number may double by the year 2000 and double again by the year 2020.

Results of a recent demographic study on the disabled population in Canada are not yet available. However, the federal government estimates that 5.6 percent of the mobility-limited disabled persons are wheelchair bound, 24.2 percent require other mechanical aids, 21.2 percent have visual impairments, 21 percent have hearing disabilities and 46.3 pecent have minor dysfunctions affecting their coordination.

In addressing this situation, our Association adopted the view that an across the board solution would not be acceptable, not only from the point of view of transportation providers and their funding agencies but principally from the point of view of the users.

At the beginning of the 1970's, transportation for the disabled was at the embryonic stage in most provinces. However, by the end of the decade, policies to foster this type of transportation were adopted by most of the provinces. From less than 50 operators of transit services for the disabled in Canada in 1979, the number grew to over 200 in 1983; however, only 120 municipalities offer conventional public transit services at this time.

Regular Transit vs Parallel Service

The most controversial policy issue in providing transportation service for the disabled in our cities concerns the people who have the greatest need, namely, these confined to wheelchairs. One viewpoint holds that existing transit services should be made fully accessible to people in wheelchairs through the provision of ramps, elevators, and lifts, while others argue that they should be provided with a special customized service using appropriate vehicles, on a demand-responsive basis.

This is an emotional issue, and has become a point of principle. A parallel service is seen by some disabled people as less desirable than integration with the sytem that everyone else uses. However, in terms of the actual mobility provided to the wheelchair-bound patron, it has been shown that a specialized demand-responsive system can provide much better access to the community than major modifications to the existing service could, especially when relative costs and climate conditions are considered.

When we discuss mobility, we must consider, as shown on Table 1, that limitations differ from one person to another, according to the type of disability from which one suffers, the degree of influence of the physical environment on his functional limitation and the constraints related to the use of conventional transit.

TABLE 1

Mobility Limitations

1. Relating to the person
    - a) Use of prosthesis
    - b) Physical limitations (coordination, strength, etc.)
    - c) Organic limitations (cardiac problems, breathing, incontinence)
    - d) Psychological limitations
    - e) Limited autonomy
2. Relating to physical environment
3. Relating to regular public transit

For example,

- Distance is too great between bus stop and either user's residence or place of destination.
- Duration of trip is too long.
- Complexity of transfers or bus schedules.
- Short dwell times at transit stops, especially in subways.

For any individual, there are at least five steps in making a trip:

- Moving from home to vehicle.
- Boarding the vehicle.
- Experiencing a safe ride.
- Alighting from the vehicle.
- Going from vehicle to destination.

Solving some of those elements does not mean that the entire mobility problem is solved. Adding ramps on regular transit buses only solves the boarding and alighting from the vehicle whereas a special transit service for the disabled brings an effective solution to the constraints which a handicapped person has to face in one's movements.

Other advantages of a parallel service are:

- Better possibility for all disabled to make the trip.
- Elimination of problems of access to bus stop and from the bus stop to the final destination.
- Elimination of the discrimination on access to all forms of activities.
- Better quality of service.

CUTA's Policy

It is with these considerations in mind that CUTA developed a policy where a guiding principle is that regular transit should be made more accessible to the disabled (see Table 2) To this end, CUTA has encouraged its members to modify its transit systems in ways which would improve accessibility for the disabled. Modifications such as escalators at stations, more hand rails and stanchions on transit vehicles, priority seating have gone a long way towards making transit accessible to the ambulatory disabled.

TABLE 2

Summary of CUTA Policy on Urban Transportation for the Disabled

- The disabled are entitled to and should be given affordable and efficient transportation.
- The range of disabilities requires transportation solutions ranging from improvements to existing transit to special services for wheelchair users and others with severe disabilities.
- All three levels of government should provide funds to make this transportation available.
- Research and development should be accelerated.
- Transit managers should provide technical and managerial assistance.

Retrofitting our major rail systems to accommodate wheelchairs was and still is considered inappropriate and ineffective by CUTA. We feel it does not solve some of the steps mentioned above and it does not solve the problem of the waiting periods between transfers.

Our severe climate conditions would simply prevent access to buses and rail systems by passengers in wheelchairs. Door-to-door services with lift equipped vehicles are more productive and cost effective. We realize that the users of these services are in effect segregated from other users of public transportation; however, we believe strongly that this approach provides mobility for a greater number of Canadians allowing more disabled people to achieve access to jobs, education, medical and recreational facilities, at a reasonable price.

We consider it important to develop accessibility to all sorts of activities for disabled persons rather than to concentrate exclusively on public transit.

The policy of CUTA reflects this point of view in encouraging the use of transportation modes the least specialized as possible, taking into account not only the factors limiting the mobility but also the cost involved in the process.

General Considerations

Table 3 shows some data for four of the largest provinces in population terms. It highlights the evolution of transportation for the disabled during the last four years, the number of operators and the hours of operation during that period while the ridership and the subsidies increased by two and a half times.

TABLE 3

Data Trends for Quebec, Ontario, Nova Scotia, British Columbia[1]

	80/81	*81/82*	*82/83*	*83/84*
Number of Systems	51	92	105	112
Ridership (000)	1,151	1,954	3,197	2,825
Vehicle Hours (000)	671	990	1,204	1,251
Financial Subsidies(000)	$ 8,750	15,9	37,209	22,484

$ = Canadian Dollars

[1] 75% of Canadians reside in these four provinces.

SOURCE: CUTA Government funding policies for urban transit in Canada.

Over the years, CUTA developed a general statistical questionnaire. It enables the Association to have a better understanding of the overall situation in Canada.

The operators may have between one and one hundred vehicles equipped with manual or hydraulic ramps; the operations may be simple or more sophisticated where computerized dispatch systems are in use. Some use one type of vehicle, others use different types of vehicles.

A wide variety of administrative structures have been developed; municipal departments and transit commissions are the most popular forms. In terms of operating the system, most municipalities prefer to sub-contract the service to a private contractor. The vast majority of parallel services for the disabled require all users to register with the operator. Most systems require some sort of verification that the person is actually disabled. This verification is usually referred to an eligibility committee for a final decision. However, despite the above standardization of registration procedures a wide variety of eligibility criteria are used to determine whether or not a person qualifies for the special service.

Eligibility Criteria for Service

To ensure that the available funds are used by those in greatest need, the provincial and municipal governments have adopted eligibility criteria for use of the services. The application of these criteria is, as one can imagine, difficult at times. It is fair to say that in borderline cases decisions are usually ruled in favor of the user. Table 4 shows eligibility criteria used in three specific provinces.

Most municipalities limit service to those unable to use regular transit or those unable to use regular transit with dignity. Other criteria include persons whose mobility severely inhibits or prevents the use of regular transit and some systems which put the emphasis on those unable to utilize regular transit services effectively without the addition of specially designed facilities.

TABLE 4

Typical Eligibility Criteria for Disabled Persons

(in three specific provinces)

Ontario	For use by those with physical handicaps which prevent them from using regular transit.
British Columbia	For disabled persons unable to use conventional transit without assistance (income or age are not considerations). This includes: blind persons, permanently and temporarily disabled persons.
Quebec	For use by a person limited in the performance of normal activties who is suffering significantly and permanently from a physical or mental deficiency or who regularly uses a prosthesis, or orthopedic device or any other means of compensating for one's handicap.

1983 CUTA User Survey

In 1983, 106 out of a potential 185 operators returned their annual questionnaire to CUTA. Those that did not respond were mainly operators with one vehicle. Consequently, the absence of their data had a limited effect on the overall statistical picture of transportation for the disabled in Canada in 1983.

The 106 systems reporting carried over 3.2 million passengers while operating 1.2 million hours. The financial subsidies were $37.2 million. some 34.8 percent of the 89,664 registered users were wheelchairbound, the remaining 64.2 percent were ambulatory. The number carried per hour ranged from 0.50 to 6.45 with an average productivity of 2.39 persons.

Unlike regular transit services where work trips commonly account for 50-60 percent of all trips made, the predominent trip taken by disabled users of services are medically oriented trips. Overall, medical trips account for 26.4 percent of all trips made, work trips 20.1 percent, recreation/social trips 22.7 pecent, education trips 14 percent, shopping trips 14.3 percent and other trips 2.3 percent.

Due to the type of service operated, almost all parallel services for the disabled have a trip priority reservation system. Overall work oriented trips have the highest priority, followed closely by medical trips and education-oriented trips. No system gave top priority to recreation, entertainment, shopping or socially oriented trips. However, a reservation system based on trip purpose is expected to disappear in the future. There is movement in some provinces to have that system abolished because it is seen as discriminatory when compared to regular transit.

Transportation Expenditures for the Disabled

In 1983, services for the disabled in Canada cost $40.0 million, with the six largest systems accounting for over half of the above total. Due to the diversity of service levels, fair structures, wage rates, etc., the cost per trip and cost per hour of service vary widely.

On an overall average, each trip by a disabled person cost $12.70 while each hour of service cost $27.37. Due to the relatively high cost of providing parallel services for the disabled, only 10.3 percent of the total cost is assumed by the user. The remainder is provided by provincial and municipal governments in the form of financial subsidy.

In 1983, municipal governments provided $16.7 million in financial assistance (44.9 percent), provincial governments $16.4 million (44.2 percent) and other sources $0.24 million (0.60 percent). Obviously the level of government support varies from province to province due to different fianancial assistance policies.

In general, the financial policies are less complicated than those for conventional transit, although both Ontario and British Columbia include a performance incentive for disabled transit. Nova Scotia, Alberta and Saskatchewan provide per capita operating grants, and Quebec, Ontario, Manitoba and British Columbia use a percentage-of-deficit formula.

Because of the door-to-door nature of these services, they are costly to operate when compared to regular transit. Providing full accessibility on buses and subway systems would produce greater costs per passenger because of the poor utilization of services accessible to the disabled.

Conclusion

Providing mobility for the disabled is a very complex issue. The variety and diversity of requirements are so great that no single transportation option could solve the variety of problems encountered.

We have come a long way in Canada but there still are some barriers that we have to overcome, and no law can overcome, such as changes in attitudes to the introduction of new technologies. A better understanding will certainly contribute to improved transportation for the disabled.

We believe that our policies have served the needs of the disabled. This does not mean that our future views will not change. We are now in the process of reviewing our policy statement to ensure that they are relevant to today's situation and will serve the needs of the disabled of tomorrow.

We cannot aim to be a strong and prosperous nation without making choices. This is not an issue for transportation only. Compassionate and efficient decisions must be made in allocating public funds. We cannot simply consider those we are serving but also those who are providing the resources. In times of fiscal constraints, there are no easy solutions, only tough choices.

Sources of Information

Canadian Urban Transit Association (CUTA): (a) Government Funding Policies for Urban Transit in Canada, Committee of CUTA on Government Funding, Toronto, Ontario, May 1984. (b) Policy on Transportation for the Disabled, Toronto, Ontario, November 1983. (c) Urban Transit Facts in Canada, 1983 edition, Toronto, Ontario, 1983.

Canadian Transit Handbook, 2nd edition published by CUTA and RTAC, Chapter on handicapped services by Greg Latham, Toronto, Ontario, 1984.

Corporation Municipale de transport de Sherbrooke (CMTS): Plan de developement, transport adapte, prepare par Forcier, C., Sherbrooke, Que, Canada, Juillet 1981.

Government of Quebec Minister of Transport: Policy on eligibility for adapted transport for disabled persons, Surface Passenger Transport Branch, Quebec, Que, April 1983.

Hickling Partners Inc.: A Review of Urban Transportation Services for Disabled Persons, Transport Canada TP4436E, Ottawa, Ontario, 1983.

Office des personnes handicapees du Quebec (OPHQ): A part . . . egale, l'integration des personnes handicapees: un defi pour tous, Bibliotheque Nationale du Quebec, B.N.C., Gouvernement du Quebec, 1984.

Statistics Canada: Statistiques historiques du Canada, 2ieme edition, Centre d'edition du Gouvernement du Canada, Approvisionnements & Services Canada, Ottawa, Canada, 1983.

Claude Forcier, Chair, Committee on Transportation for the Disabled, Canadian Urban Transit Association; and Manager of Operations, Municipal Transit Corporation, Sherbrooke, Quebec, J1K 2M3, Canada.

TRANSPORT FOR THE DISABLED IN HONG HONG

John Collins

Introduction

The purpose of medical, vocational, educational and social rehabilitation is to enable the disabled person to return to society as a person of some value and with his self-respect restored. This goal is frustrated if the disabled person is unable to obtain transport, or to enter buidings either to undertake employment or to participate in community activity or even to visit friends. Without transport and accessibility rehabilitation becomes a meaningless exercise. Any rehabilitation-minded person visiting Hong Hong today will quickly realise how very difficult public transport is for a disabled person, especially anyone with a serious mobility problem. This was even more obvious around 1974 when even the able-bodied had to fight their way into and out of buses. So when word went out that year that the government was planning a Mass Transit (underground) Railway (MTR), the Joint Council for the Physically and Mentally Disabled, which is Hong Kong's national coordinating body for rehabilitation, requested that the MTR be made accessible to the disabled.

The Pilot Scheme

This request was met with an absolute refusal; one result, however, was that the government set up a Working Group to study surface transport for the disabled. The Joint Council suggested the Working Group establish minibus service to cater to the travel needs of disabled people. This suggestion was received favourably and the Access Committee of the Joint Council was asked to initiate the service for six months to test its feasibility.

Before putting any minibuses on the road it was decided to explore the demand. A limited area which was both residential, industrial and densely populated was selected for the demonstration. Registration forms were mailed to handicapped clients of the various voluntary agencies and government departments in the target area. Within three months fifty six handicapped people registered for this service in East Kowloon. Two minibuses were placed in operation. In May 1977 a pilot scheme was launched with two borrowed buses and drivers, and a total of HK$9,500 (US$1,218) received in donations.

Later in the same year a wider survey brought in 200 applications. By the end of 1977 we were serving 117 persons with our two minibuses and we had a waiting list of at least 154. It became clear that the minibus service was needed.

Establishment and Growth of the Rehabus Service

After the Joint Council for the Physically and Mentally Disabled had completed the pilot project and proved its worth, the project was transferred to The Hong Kong Society for Rehabilitation because the Joint Council is a coordinating body and is not allowed by its constitution to undertake any permanent direct service. The Hong Kong Society for Rehabilitation agreed to take over in June 1978 on condition that full financial support would be forthcoming from the government. It was decided to identify the special service by the name "Rehabus"; an office was set up and a manager employed to run the service. A Rehabus Committee was set up by the Society as the direct controlling unit of the Rehabus service. Members of this committee include representatives from the Transport Department, the armed services, one of the bus companies, and some members of the Executive Committee of the Hong Kong Society for Rehabilitation.

As of 1984, The Society for Rehabilitation, which is a voluntary non-profit organisation, operated a fleet of 12-seater minibuses plying 17 routes. The number of passengers carried daily on Rehabus scheduled routes during 2nd Quarter of 1984 was 204.

Service Priorities

Screening of potential clients is necessary to set certain priorities, both with regard to the type of disability and the purpose of the bus trip. The following categories were agreed to by the Social Welfare Department, the subventing body:

Type of disability:
1st priority—wheelchair bound
2nd priority—persons using crutches or calipers
3rd priority—multiple handicapped
4th priority—the mentally retarded:
  (a) lower moderate and severe grades,
  (b) young females,
  (c) males, moderate grade
5th priority—the blind—on a temporary basis

Purpose of trip:
  (a) employment
  (b) education or training
  (c) medical treatment
  (d) leisure, recreation and sports activities

Young handicaped, especially mentally retarded females, were included because parents are often anxious about their child's safety when travelling alone or on public transport.

Application Procedure for Rehabus Service

Applications for this service are normally made by telephone, either by an agency or by the disabled person. The Manager has first to satisfy himself that the person applying, or being applied for, fits in with the criteria for qualification. If the prospective client is recommended by an agency, or has been known to an agency in the recent past, the necessary information about his disability can be obtained easily. If the client has no such connection, one of the Rehabus staff may have to visit him or her to see whether the client qualifies for service. The Manager has then to survey the existing scheduled routes to see if this person can be fitted into a route which responds to that person's needs. Sometimes the Manager will even readjust some scheduled route in order to meet the requirements of the client. If he cannot fit into the existing routes he is put on the waiting list.

The waiting list over the past year has varied between 60 and 100 persons and is changing constantly. Some drop out and new applicants surface. A survey made of those who have dropped out indicates some have waited so long that they have given up hope or found other means of travel. Others have lost or changed their jobs, or have had to return to hospital for medical care. But, with twelve-seater buses, even a waiting list of 60 suggests a demand for 5 more buses.

The Manager of the Rehabus Service has to be a person who has interests and knowledge above and beyond just administering the bus service. The disabled person making a phone request may reveal that he or she has other serious problems, e.g. a problem of getting from a high rise building to the street, or some special medical problem. The Manager has to be alert to such situations and be ready to refer cases to the appropriate service where necessary.

Financing the Rehabus Service

It is appropriate to ask: where does the money come from to run this scheme? And there follows that rather frightening and often misused question: is it cost-effective? Personally, I am suspicious of any social service which is judged only by its "cost-effectiveness." There are so many elements and aspects of the rehabilitation of handicapped people that are invisible yet represent invaluable gains, as for example, self-respect and family happiness, along with the more visible forms of employment and economic self-sufficiency.

Service Costs

It is only possible to recoup a fraction of the running cost from the fares charged because the Rehabus fares must necessarily bear a reasonable comparison to the fares charged for other forms of public transport. It is to be noted that Hong Kong buses and trams do not charge according to zones but charge a flat fare for the journey. Six years ago the fare was HK$0.5 (US$0.064)[1] per trip on scheduled routes regardless of distance. The present fare is HK$2 (US$0.26) per trip which is a little more than twice the ordinary bus fare or 40 percent of taxi fare. In fact the average man-trip on scheduled routes today costs HK$13.50 (US$1.73), or about HK$25 (US$3.2) after depreciation and provision. Fares collected represent approximately 10 percent of the total income. It is obvious, therefore, that the scheduled routes do not pay for themselves. To quote from the last quarterly report: the average monthly operating cost (including repairs) was HK$84,815 (US$10,874). This requires a government subsidy of HK$430 (US$56.8) per seat per month.

We made several intensive studies including experimenting with an area approach, to see if we could run the service more economically. Notwithstanding valuable assistance from experts in the Transport Department, we have not yet succeeded in reducing the cost.

Apart from the fares collected the main financial support for the Rehabus service comes from an annual government subvention, with a small grant from the Hong Kong Community Chest. Although this is no small commitment, it must be noted that by providing this bus service some ninety-four handicapped people are now in employment. If they were not working many would be receiving Public Assistance, currently HK$510 (US$63.4) per month, plus allowances for rent, education of children etc. About 40 percent of those at work today are on a salary scale which, in some cases at least, means that they are paying income tax as well.

Special Service Costs

There is a special service provided by Rehabus which the government is not called upon to support. We call this special service the Dial-a-Ride Service. It caters to groups who need transport on weekends when the buses are not in demand for scheduled routes. On these occasions the Rehabus is hired to bring groups of handicapped people and their friends or relatives to the beach, or to centres providing recreational or cultural facilities or sometimes to meetings of their various associations. On these occasions (which are very frequent, for it is a popular service) the fare charged is much higher since it has to be self-supporting, which means that it has to cover the overtime pay of the drivers, and the cost of fuel. The hiring cost in 1984 is HK$15/hour (US$1.92), plus HK$1 (US$0.13) per mile. This charge, of course, makes the cost prohibitive if the bus is hired by one or two individuals, but is quite reasonable when shared by a full, or nearly full, bus load.

---

[1] In this paper the exchange rate of HK$7.8 to US$1 is used throughout.

Purchase of Buses

During the initial experimental period and also after the Society for Rehabilitation took over the scheme, efforts were made to arouse public interest. Press conferences were held and the mass media began to take a very active interest in the progress of the scheme, so much so that during the experimental period not less than 20 interviews with the press, radio and T.V. took place, and talks were also given to various service clubs and other groups. The result was that groups like the Lions Clubs, the Jockey Club, two large banks, commercial firms, the Kowloon Motor Bus Co. and even the Mass Transit Railway Corporation provided minibuses to expand our service. This year seven new Ford Transit vehicles purchased to replace the old and worn out seven-seaters were bought with a grant from the Social Welfare Department. In general, therefore, we can say that the addition of new buses to our fleet is not our major problem. Replacement of vehicles, however, will have to be funded mainly from government sources. The running costs, nevertheless, are a constant concern.

Technical Requirements for Rehabuses

After a careful evaluation of various makes of minibuses we have now replaced the original smaller buses with twelve-seater Ford Transit vans each with a tail-lift for wheelchairs. Having similar vehicles helps also in arranging for a maintenance package from the purchasing agents, which has obvious advantages.

It might be of interest to look at some of the problems faced in evaluating the feasibility of modifying other makes of minibus to suit our requirements. In some cases where there was no built-in rear door, the alterations needed would affect such a large area that there was danger of weakening the whole structure and the possibility of recurring repair bills. Another effect of modifying a vehicle was the loss of seating capacity even after repositioning the seats. In one case the floor of the car was considerably higher than that of the Ford Transit, thus causing difficulty for those using crutches or other walking aids.

We do not use larger buses because our service is a door-to-door service. The handicapped person is brought from his home (or the point nearest his home), to his place of work or study and subsequently returned to home. This means that the number on any one bus must be limited otherwise there would be a long waiting period between the first person to take the bus and the last. Hence, small buses are more feasible than large ones.

The Five Year Plan

As a result of our experience over the past years, we recently drew up a five year plan which was based on careful review. In forecasting our future needs we felt we could not go far wrong if we based our projections on estimates of the various types of disability cited in the Hong Kong Government's Rehabilitation Program Plan which, with the cooperation of the voluntary agencies is updated yearly and sets targets up to ten years in the future.

In following this method we have taken into account various studies that have been made and official forecasts of various categories of the disabled who would, over the next five years, need special transport. For example, estimates of the number of physically handicapped in secondary schools, of physically disabled persons attending adult education centres or needing transport to attend evening educational, social or recreational activities; statistics and forecasts of young female mentally handicapped people; and, of course, the average yearly total of victims of traffic and industrial accidents, not forgetting to relate all this to the growth of Hong Kong's population.

As a reasonable response in part, at least, of the problem of transport for Hong Kong's disabled population, the following comparisons have emerged:

a. The minimum provision calls for a fleet of 28 Rehabuses by 1989-90, at a cost to the government of approximately HK$2.3 million (US$295,000). Response to demand: 5 percent.

b. The middle-course plan calls for a total of 40 buses in action by 1989-90, at a cost to the government of HK$3.3 M (US$423,000). Response to demand: 10 percent.

c. The maximum planning provision calls for a total of 84 buses in 1989-90 at a cost to the government of HK$6.8 M (US$872,000). Response to demand: 30 percent.

If these estimates seem high it should be noted that the maximum government commitment noted above (HK$6.8 million) would represent only 0.5 percent of the government's social welfare total recurrent expenditure for 1982-3. This compares poorly with a recent statement made by the Rt. Hon. Tom King, British Secretary of State for Employment, who said: "We (that is, the British Government) can also provide a grant of up to US$43 (57.5 pounds sterling) per week to assist a severely disabled person who cannot use public transport to get to work."[2] Nevertheless our Rehabus Committee has recently been discussing the pros and cons of sub-contracting the Rehabus Service to a reliable transport company. According to this plan we would retain ownership of the buses, and the transport company would obtain a franchise from us. This alternative has not yet been seriously discussed by our Committee but it is likely that we may examine it more seriously at some time in the near future.

Other Forms of Transport

We have never considered the Rehabus as the only practical means of transport for our disabled people. Several years ago a Catholic priest in Hong Kong, a paraplegic who drives his own car, was beseiged by many of his disabled friends and pupils to teach them to drive his specially modified car. He began to teach others but eventually finished up with a waiting list of a hundred young handicapped men wanting to learn to drive. Eventually the Hong Kong Federation of Handicapped Youth agreed to take over this instruction. The Transport Department cooperated by smoothing out various difficulties and shortening the waiting period for the driving test. The result is that today in Hong Kong there are 271 handicapped persons with full driving licenses, and of these 214 are driving their own cars. The effect of this has been well described by one of these handicapped drivers when he said that he now felt truly liberated: he could, whenever he wished, get into his car and drive where he wanted, visit a friend, go to a beach, or attend a function. There are special parking privileges and tax exemptions for disabled drivers. It may be of interest to point out also that Hong Kong has now three disabled taxi drivers.

Volunteer Drivers

Hong Kong's Agency for Volunteer Service has also organised a group of volunteer drivers who use their own cars to drive disabled people to their destinations. There is quite a good response to this although of course no volunteer can do this on a regular schedule but only for specific journeys.

Total Mobility

We are interested, too, in a new project just beginning in New Zealand called "Total Mobility." In general it is planned to equip various taxi company's fleets with a number of seven-seater taxis specially equipped to take wheelchairs as well as able-bodied passengers so that a disabled wheelchair user will be able to call a suitable taxi at any time of the day or night. Attached to this scheme is a voucher system by which the disabled taxi passenger is eligible for a fare reduction of 25 percent.

Transport Alone is not Enough

I end with a comment on an issue that goes beyond transport. I began this paper by stating that rehabilitation without transport becomes a meaningless exercise. I go further and say that transport without access to buildings is equally frustrating. Transport for the disabled cannot be discussed in isolation. There is no real solution unless the building or park or place of entertainment to which the various forms of transport bring the disabled person is accessible. In Hong Kong the title of our main committee dealing with barriers links these two problems. It is called the Access and Transport Committee.

Rev. John Collins, SJ is Vice-Chair, Hong Kong Society for Rehabilitation and is with Wah Yan College, 56 Waterloo Road, Kowloon, Hong Kong.

---

[2] New Outlook, Spring 1984.

THE MOBILITY AND TRANSPORT OF HANDICAPPED PERSONS IN DEVELOPING COUNTRIES: THE CASE OF JORDAN

Abdelgader O. Elshabani

Introduction

Analysis of the situation of disabled persons in developing countries, especially in terms of the problem of mobility have to be carried out within the context of different levels of economic and social development and different cultures in which the handicapped population find themselves. This paper will discuss the physically handicapped population in Jordan and major public policy questions affecting their mobility. Perhaps some of the discussion could be useful to other developing countries with conditions similar to those of Jordan.

According to a United Nations report on handicapped persons, in 1983 more than 500 million people in the world were handicapped. The proportion of handicapped persons to the rest of the population was estimated to be 1:9. In some developing countries the ratio of the handicapped population is estimated to be as high as 1:5 or 20 percent of the population. Thus, if families and relatives are included, 50 percent of the population could be adversely affected by the handicapped person's loss or limitation of opportunities.

In many developing countries, little is known about transport problems of the handicapped. Identification and recognition of the numbers of handicapped in different countries and the nature of their travel needs are the first steps towards providing appropriate solutions.

In Jordan, there has been considerable interest in the effort of governmental institutions over the last few years to improve the conditions of handicapped persons. However, one area that still need considerable improvement is that of mobility. This paper will concentrate on one segment of the transportation handicapped in Jordan, namely the physically handicapped. It will discuss major public policy questions affecting the mobility of this group that should be considered by government to illustrate what could be done in developing countries.

Mobility problems of handicapped persons in developed countries has been extensively studied. Few similar studies have been undertaken in developing countries, as the problem may at first seem relatively unimportant compared with the more immediate problems such as lack of education and malnutrition.

As indicated, more than 500 million people in the world are disabled. They are handicapped by their inability to be integrated into the mainstream of community living. In developing countries, the problems of disability can be highlighted by the fact that as much as 80 percent of all disabled persons live in isolated rural areas; usually are extremely poor; and resources to detect and prevent disability and to meet the need for rehabilitation and supportive services for the disabled population are not sufficient (UN 1983).

The Handicaped in Jordan

At present (1984), there is no precise statistical information about the handicapped population in Jordan. A national survey by the Queen Alia Jordan Social Welfare Fund (QAF), indicated that in 1979 there were 18, 829 handicapped persons. This represent 0.85 percent of the population in Jordan (QAF 1983). A survey by the Statistical Department in Jordan indicated that in 1983 there was only 11,396 handicapped persons in Jordan (Statistical Department 1983). The 1983 statistical survey findings appear to be questionable. Over the last few years Jordan has been experiencing a very high road accidents rate (as will be shown later in this paper) which, it is assumed, would have increased the overall number of handicapped persons between 1979 and 1983.

Table 1 indicates the categories, numbers and percentages of the handicapped persons in the 1979 QAF National Survey. It shows that the physically handicapped represent 6,479 persons or 34.2 percent of the total sample.

Table 2 indicates the occupation of amputees before and after amputation. It shows that the unemployed have increased from 9 percent to 33 percent and that the percentage of skilled workers was reduced considerably. This could be explained partially by the lack of suitable jobs for skilled workers after amputation and lack of mobility for the handicapped population.

Among the serious reasons for physical disability are road accidents. Traffic Police Department Statistics indicate the changes in the number of accidents and casualties between the years 1970 and 1983. In that period there was an average annual increase in accidents of 38.77 percent, with a 16.31 percent average annual increase in those killed, and 28.62 percent average annual increase in those injured. The comparable average annual increase in the population for such occurrences in that period was 4 percent (Statistical Yearbook 1983).

TABLE 1

Categories, Numbers, and Percentages of the Handicapped in the Total Sample of the 1979 Queen Alia Jordan Social Welfare Fund (QAF) National Survey.

Category	*Number*	*Percent*
Deaf and Mute	3193	16.9
Blind	2088	11.2
Deaf, Mute and Blind	1704	9.1
Deaf and Blind	40	.2
Partially Paralyzed	4857	25.8
Fully Paralyzed	926	4.6
Hand Amputated	246	1.3
Leg Amputated	352	1.9
Arm Amputated	78	.4
Hand and Leg Amputated	11	.1
Leg and Arm Amputated	9	.1
Severe Mental Retardation	2127	11.3
Mild Mental Retardation	2741	14.6
Emotional Disturbance	457	2.4
Total	**18,829**	**100**

SOURCE: Reproduced from Evaluation Studies of Handicapped Persons in Jordan 1983 Table (1) Page IX.

TABLE 2

Occupation of Amputees, Current and Before Amputation

Occupation	*Before amputation percentage*	*Current percentage*
Student	31	27
Housewife	9	7
Businessman	2	2
Skilled worker	27	13
Unskilled worker	22	18
Unemployed	9	33
Total	**100**	**100**

SOURCE: Reproduced from *Evaluation Studies of Handicapped Persons in Jordan 1983,* Chapter 3, Table 2.

The above statistics indicate that Jordan has a serious problem with road accidents which disable many people every year. Despite the fact that there is no reliable statistical information on all the physical handicapped, available information indicates that amputees lose their jobs after amputation partially because of the lack of mobility.

Mobility of Handicapped Persons in Jordan

Mobility Problems

Mobility is a critical factor in the full participation of handicapped persons in community life. Accessible transportation is the link which links handicapped persons to education, employment, health, social and recreational opportunities.

There has been considerable interest in the Jordanian government and volunteer organizations in the last few years to better the life of handicapped persons in Jordan; however, one area that handicapped persons still face a serious problem is in the transportation area.

Generally, the problems faced by handicapped persons moving from home to work and to other needed activities are:

- Transportation services for the physically handicapped, and especially those in wheelchairs, simply are unavailable. The existing public transit system is composed of buses, service taxis, and call taxis. Vehicles in the existing transit system are not especially equipped for the transportation of handicapped persons. Nor are hospitals and other health centers adequately prepared with special vehicles for the transportation of handicapped patients to their facilities.

- At present (1984) there are no studies which indicate the trip destination of the handicapped population on daily basis such as, the number of trips needed or the time and location of these trips. This information is necessary to plan and provide adequate transportation services.

- Sidewalks of the streets in urban areas of Jordan are difficult for the physically handicapped to use. These problems include: narrow sidewalks, cars parked on the sidewalks, open ditches and the like. There are no spaces reserved for vehicles used by handicapped persons. Public buildings have many architectural barriers which make it difficult for the handicapped persons to gain access to those buildings.

- The government of Jordan allows handicapped persons to import especially equipped cars for their personal use without having to pay oustoms. Customs fees on cars in Jordan could cost as much as 50 percent of the total cost of the car. The government introduced a policy that imported cars should be modified so that a non-handicapped person would not be able to use them. The government's purpose is to prevent misuse of the policy of free customs for the handicapped. However, this puts additional financial burden on handicapped persons since other members of their families are denied use of these cars.

Mobility Solutions

The government of Jordan plays a major role in providing funding and in regulating transportation. It can make transportation services more accessible to disabled persons through the adoption of the following proposed public policies.

- Comprehensive transportation studies in Jordan in recent years while generally of high standard have neglected estimating the travel needs of the handicapped population in Jordan; these studies are often "demand oriented." An example of such studies is the Amman Region Transportation Study by Halcrow Fox and Associates, Jousy & Partner Consultants in 1980.
- Future comprehensive transportation studies should include special sections on estimating the travel needs and the transportation services required by the handicapped.
- Call taxi companies in each city should have a minimum number of vehicles especially equipped for transportation of the handicapped. The number of vehicles would depend on the number of handicapped. The cost of the transportation of the handicapped should be subsidized partially by government.
- The government of Jordan should continue with its present policy of free customs on especially equipped vehicles for the handicpped; however, these imported vehicles should not be modified so that other members of the handicapped persons family are denied use of these cars. In addition, the policy should be modified so that a handicapped person may import a maximum of two cars, duty free for personal use as well as for family use. If possible, easy term loans should be made available to handicapped persons for the purpose of purchasing especially equipped vehicles.
- Health centers, such as hospitals, should have specially equipped vehicles to transport the handicapped from their place of residence to health centers.
- Licensing procedures for public building should include special provisions which would eliminate architectural barriers for the handicapped person to facilitate access to those buildings.
- Responsible government agencies should enforce strict policies regarding the adequacy of sidewalks for the movement of handicapped in wheelchairs.
- Special reserved parking spaces for the handicapped persons vehicles should be designated on city streets.
- In addition, other known traffic engineering measures which would facilitate the movement of handicapped as drivers and as pedestrians should be undertaken.

Conclusions

Very little information is available on the mobility of handicapped persons in developing countries. There is much research to be done in this area. Mobility needs should be studied within the context of different levels of economic at social development and the different cultures in which the handicapped populations live in. However, strategies that would be suitable to a group of countries with similar conditions could be investigated and addressed.

In Jordan, mobility problems of the growing number of physically handicapped person include:

a) No suitable public transit service available for the transport of the handicapped; no adequate numbers of suitable transport vehicles are available at health centers.

b) Sidewalks of the streets in urban areas are difficult to use by the wheelchaired handicapped; generally there is a lack of traffic engineering regulation and enforcement to facilitate the movement of the handicapped.

c) Regulations regarding specially equipped imported vehicles to be used by the handicapped are unnecessarily restrictive.

Mobility solution of the physically handicapped would include:

a) Conducting transportation planning studies of the handicapped population to identify the numbers, their mobility needs and the transportation services required.

b) Providing a adequate number of especially equipped vehicles at call taxi companies to provide transportation services for the handicapped.

c) Facilitating the purchase of cars for personal use by the handicapped and their families.

d) Removing architectural barries from public buildings to facilitate access of handicapped persons to those buildings.

e) Implementing traffic regulations and their enforcement to facilitate the movement of handicapped persons using the street system.

References

World Programme of Action Concerning Disabled Persons. United Nations, New York, 1983 pp. 1-13.

Evaluation Studies of Handicapped Persons in Jordan, 1983. The Queen Alia Jordan Social Welfare Fund, Amman, Jordan.

A Survey of the Handicapped in Jordan, 1983. The Statistical Department, Amman, Jordan.

The Statistical Yearbook, 1983. The Statistical Department, Amman, Jordan.

Abdelgader O. Elshabani, Assistant Professor, Department of Civil Engineering, Yarmouk University, Irbid, Jordan.

DEVELOPMENTS IN THE AREA OF THE TRANSPORTATION OF HANDICAPPED PERSONS IN THE NETHERLANDS: SOME SOCIOPOLITICAL, FINANCIAL AND TECHNICAL APPROACHES

D. A. Vogelzang

The Problem

Mobility and transportation of elderly and handicapped persons has for years been a focus of interest in various countries. The technical problems would appear to be solvable. The amount of money which is used for the purpose of transportation of the handicapped is sizeable. Highly industrialized, more affluent societies have the ability to furnish the means to find an efficacious solution for the transport problems of their handicapped citizens. However, this is not happening. Such societies seem not prepared to look for an actual solution. Transportation for handicapped people turns out to be a political matter and it is characteristic of political problems that they cannot always be solved easily. In particular in the case of transportation for the handicapped, technical and financial sophisms have been used to keep political problems unresolved.

In every society handicapped citizens are impotent because they are relatively few in number and have little political or economic influence. Also people are not anxious to get involved. In a democracy everything is done for the sake of the majority, directly or indirectly. A policy which is not important either ideally or materially for this majority often turns out to be infeasible. As far as transport for handicapped people is concerned, this political maxim means that desirable measures are limited on one hand by overall aims of the transportation policy and on the other hand are conditioned by the prevailing view that the society has of handicapped life.

Social Parameters of the Dutch Community

Foreigners encountering Dutch society sometimes get the notion that they are seeing an example of the European welfare state, whatever that may be. Unfortunately they are not far from the mark. The guaranteed minimum income in the Netherlands is the highest in the world and the same applies to about 33 percent of the professional sector who are either incapacitated with respect to work or are registered as unemployed. Sixty percent of the national income is used to finance the public sector, which makes it one of the most costly in the whole world. The expecations for the future of this materially impressive society are expressed by the 23 percent of adults who are thinking about emigrating[1] (but in fact do not do so), by the greater number of the young who prefer a job as a civil servant instead of the uncertainty of a job in industry, and the remarkably high number of young people who aim at being employed in the public sector. One cannot discern a true concern for the problems confronting handicapped people in a society in which one out of every four persons fantasizes about leaving the country and in which young people view prospective jobs largely with a view to their own financial security.

On top of this the welfare system is a complicating factor. In the Netherlands because of social legislation the size of the public sector of our economy has been increasing steadily since the middle of the sixties. In a democracy this kind of development can only be initiated from the supply-side, not the demand-side. The desire for an extensive system of social security has resulted from a general rise in prosperity. Social justice required that the majority of the people be released from confronting and solving matters like illness and handicap, which did not fit into the pattern of a newly won prosperity. It also gave the protected groups amenities and provided jobs for welfare workers.

This system has divided the population in two groups: "normal" people, and a growing number of minorities for whom social measures were taken. Segregation however leads to alienation, and it is the author's opinion that this progressive alienation will lead to bias and judgement. (The shafts of moral arguments are powerles against the shield of good intentions.) Loyalty towards handicapped persons which was so much part of society shortly after the Second World War, is now practically without meaning. A majority of the population hardly recognizes the legitimate desires of handicapped people for equal rights and mainstreaming. The majority offers approval, not commitment.

---

[1] The data have been taken from press reports and publications of the Department of Social Affairs and Employment, the Department of Health and Welfare and the Socio-Cultural Planning Bureau.

In the present economic recession it turns out that it is not primarily the financing which is a problem but mainly the moral effort required for living with handicapped people in an integrated society. It is tragic that the well meaning intentions of twenty years ago have disintegrated this far. The starting point of Dutch welfare philosophy is a stubborn idealism that is part of the national character of the Dutch, one might say of the short sightedness of the petty bourgeois mind. European countries lack constitutional claims of the right to share equally in the facilities provided by government. Social rights are of a contingent nature. Therefore, in the Netherlands political demands of handicapped people cannot be translated into legal rights.

Dutch Transport Policy

In the late sixties and seventies mass motorization took place in the Netherlands (later than in surrounding countries).[2] In view of this development social legislation gave non-elderly, handicapped people the opportunity to learn to drive their own car and indeed to own a car. Apart from the fact that not all people were helped, the elderly and the blind for example were left out in the cold, though this was an excellent policy. It was a measure which even today could be adopted by other motorised, car oriented societies. This option provides maximum mainstreaming since handicapped people move about in the same way as other people and the character of traffic is not changed by the participation of handicapped drivers. It is also an inexpensive solution, for handicapped people who drive themselves do not need a driver. Even technical adaptations of vehicles for severely handicapped people may be a relatively inexpensive means of keeping them mobile.

The Dutch branch of industry specialising in car modification is one of the most advanced of the world. This industry aims more and more at exports. Dutch society has become conscious of the negative side effects of mass motorisation. The Netherlands is a small country and densely populated; in fact there are no rural areas left. The amount of space and fresh air consumed by th- massive use of private cars is considered unacceptable. The Dutch government opposes the use of private cars by constructing very few new roads and parking lots and by refusing motorized access to town centres. A byproduct of this policy is long traffic queues involving losses to industry and subsequent air pollution.

It is inevitable that when evolving a national policy which accepts a shortage of the supply of infrastructural transport facilities little attention is given to the interests of handicapped citizens, who are not only vulnerable directly but also indirectly to the consequences of such policies. If for some reason or other the average citizen is barred from enjoying the pleasure of using a car it becomes socially impracticable to have a parallel policy making it possible for handicaped people to drive a car. Considerable social privileges can only be granted to persons to whom people look up, not to those on whom they look down. In fact the decision whether or not to provide a handicapped individual with the means to drive a car (since 1980) depends on a fine balance between the interests of the individual and the interest of society as a whole.[3] How two incomparable interests can be balanced is not clear, but it would seem that the decision is conditioned by what people and the authorities consider the handicapped should deem appropriate. This cannot be other than a very vulnerable position for the handicapped.

During the last decade in Holland the share of public transport as part of the total number of journeys has increased from ten percent to fifteen percent. A further increase does not seem to be desirable from a budgetary point of view. The government subsidizes about half of a train ticket and three quarters of a bus ticket. A continuous increase in the use of public transport would seriously burden government finances. The political discussion on cost and benefits of public transport has gone on for years in Holland but this does not mean substantial changes in policy. It should be obvious that to achieve the goal of less private transport, while maintaining the same industrialised nature of a country, it will be necessary to reduce all mobility that is not economically remunerative. And this is indeed what official statistics show.

The relatively high guaranteed minimum income previously mentioned makes taxis in the Netherlands expensive. Taxis only play a minor role in the total number of journeys, about one percent. Taxi firms seem to have an extremely efficient political lobby and they specialize in journeys for which public transport or the private car are less attractive. Taxi operations would like to add to this the area of special transportation for handicapped people, but the fares (up to about thirty times the price of public transport) are so high that taxis are not a realistic means of paratransit for handicapped people. The law that limits competition between taxi companies prohibits the operation of efficient voluntary services on a non-profit basis.[4]

The Concept of Mainstreaming

Although the social conditions and the structure of transport policy in Holland is, for an affluent society, exceptionally unfavorable to the disabled, the situation is not as disadvantageous as it looks. Handicapped people are placed with their back to the wall when defending their mobility. With your back to the wall you certainly do have a solid support. A consequence is also that Dutch handicapped have learned to avoid worrying about less than ideal solutions for transportation.

---

[2] Central Bureau of Statistics (CBS).

[3] This directive can be found in the "Juridical Base Book" (1980) applying on the carrying into effect of the appropriate law.

[4] The law (WAP) will be altered, but the changes do not affect the limiting of competition.

The mere concept of mainstreaming implies that measures are taken in favour of handicapped people but create a conflict of interest between handicapped and non-handicapped and do not really solve the problem. The unfriendly political reality in Holland undoubtedly has contributed to putting the Dutch handicapped in the forefront of concepts and technical design, giving them a lead over people in some societies with more sympathy towards mobility of the handicapped.

Practically all handicapped people want to participate directly in society. They do not choose to go separately. Experience teaches us that separate arrangements are expensive, they are vulnerable to cuts in the economy and tend to be technically unreliable. If society for better or worse moves from private transport towards public transport, handicapped members of that society will have to follow that movement. Mainstreaming the handicapped into public transport however will make a difference in its appearance and its use by the able-bodied. In total this should have advantages. The unusually high requirements of such a system can only be met by using a completely new design. Traditionally design consists of two phases: first, one designs a vehicle with the specification that it does not have to be accessible for handicapped people and then one adds adaptations to make it serviceable for all potential users. This approach is undesirable from the designer's point of view, as it offers fewer opportunities to avoid the operational disadvantages resulting from the increassed accessibility.

In the Netherlands eighty percent of all trips take place close to the home. Handicapped and elderly persons are more likely to live in an urban situation than others. Thus for them access to city transport has a high priority. City transport means mostly bus transport; only in the four largest cities does this include use of tram or subway.

The Dutch Council of the Disabled therefore considered the question of whether it was possible to design a completely accessible bus (CAB) satisfying the present cost of operation of urban transport and applying existing technology. It proved to be possible. The extra expenditures due to the accessibility requirements is more than balanced by returns from increased ridership. At first this might seem incredible. The notion that mainstreaming handicapped people into general transport is an inefficient and expensive affair is cherished all over the world. Every serious designer purports to know this and reinforces his prejudices in his designs. Consequently, fully accessible public transport appears to be just as clumsy and expensive as had been anticipated, and possibly in the interests of safety, even more expensive. One cannot overemphasize how the solution of the transport problems of handicapped people is everywhere postponed by the preconception that it must cost more than is available. Dutch idealism does not here play an obstructive role.

Political Conflict

The design of the CAB found support from the consumer organisations and the senior citizens' organisations. The trade unions also approved the upgrading of public transport. Resistance came from the operators; the proposed technology met with skepticism and rejection. The technical designers were able, without too much trouble, to overcome this criticism and the feasibility of design is unchallenged, even by the most fervent opponents of the idea of mainstreaming handicapped people into public transport. Then the operational costs were questioned. This resistance was also not really successful. The final outcome was the correct but gratuitous statement that the advantages of a new design were less certainly demonstrable than the disadvantages and that only the building and operational testing of a number of CABs would produce a reasonable amount of knowledge.

Of great importance to the thinking and planning for the transport of the handicapped in the Netherlands, was a study financed and guided by the government concerning the aspects of cost. The final report of this study appeared in the summer of 1983.[5] The report is based on statistical data that show that over three percent of the Dutch handicapped population do not avail themselves of the present public transport or only with help proferred by members of the public (help which is by no means always forthcoming). Over ninety percent of this target group is ambulatory. The report gives several scenarios on the situation in the Netherlands. These are respectively: the continuation of the present policy, complete adaption of public bus and rail services for the handicapped, introduction of an equally complete system consisting of a paratransit network together with practicable intercity rail transport, as well as a scenario in which with limited means the highest possible transport performance is targeted. The results of the investigation are illuminating: the price performance ratio of measures for public transport appears to be considerably more auspicious than that of the introduction of paratransit. Alas, the figures are insufficient to arrive at a justifiable prognosis in Holland.

The Dutch parliament has several times unanimously urged the construction and testing of some CABs but has had to yield to a Minister who consistently rejected the proposal. The assumption that fully accessible public transport does not agree with governmental ideas concerning the division of the market for transport among different kinds of transporters, seems from incidental political statements to be justified.

---

[5] Altev report; transportation possibilities for disabled persons, four development scenarios, AGV, Utrecht, August 1983.

Operational and Technical Aspects of the CAB Design

In conversation with the Dutch Council of the Disabled an official of City Transport in one of the country's large urban areas mentioned three positive factors of bus design which influence performance and profitability of the transport company, (1) the greatest possible number of passengers per bus (constrained by the legal maximum measurement of 2.5 × 12 metres), (2) the shortest average boarding time, and (3) the shortest possible maintenance time (on the average one-third of the buses are kept in reserve for the rush hour and overhaul requirement). Not only the profitability but also the psychological attractiveness of public transport is increased by short boarding periods The shortest boarding time is achieved by a practically level and unimpeded entrance, as is realised in subway systems in Amsterdam, Atlanta and Washington D.C., for example. Thus a feature of public transport which is necessary for the seriously motor handicapped traveler appears to be desirable for the average passenger and for the profits of the bus company. A horizontal entrance also means the absence of entry sections with steps. The effective floor surface and in consequence the capacity of the bus is thus increased.

Subway systems use platforms. But platforms decrease the flexibility of the bus line to that of a tram or subway line. If the bus, however, during the stop "kneels" so the floor almost reaches the ground and stops alongside a pavement of normal height (in Holland 10-18 cm), the advantages of the horizontal boarding and the flexibility inherent in a bus operation are combined—always supposing that the lowering and raising are carried out quickly. Air suspension is not effective for this. The Dutch design therefore uses a combined hydraulic spring and raise/lower system. Independent front wheel and rear wheel suspension is used.

An engine cannot be placed under a floor that is practically on street level. Engine location under an elevated rear floor of a city bus is unacceptable to Dutch bus operators because of the necessary 25 cm step inside the bus. Consequently the engine has been mounted on the roof and the rear wheels are driven hydraulically. In city transport the efficiency of this transmission is equal to that of an automatic gear box. An extra benefit is that hydraulic transmission offers unique possibilities for the recuperation of brake energy and for savings on the pollution by exhaust gases of the engine. Engine breakdown accounts for about fifty percent of all bus malfunctions. An engine linked to this type of hydraulic transmission can be changed in a relatively short time, especially if the engine has been mounted on the roof of the bus.

The CAB is a joint project of the Dutch Council of the Disabled, the Technical University of Eindhoven and two internationally operating Dutch vehicle builders, Bova b.v. and Smulders Systems b.v. As far as initial expense and spare parts are concerned, the CAB will cost about 25 percent more than a conventional bus. The resulting additional operating cost will be recovered, according to studies of the higher revenues as a result of the increased capacity. The advantages of a shorter boarding time cannot be predicted easily and even less certain are the benefits of modularly constructed hydraulic transmissions.

Summary

Measures in favour of mobility and transport for the handicapped are restricted on the one hand by the overall purposes of transport policy and on the other hand by the prevailing view of society with regard to the handicapped. In the Netherlands both conditions prevail. This paper has argued that mobility demands of the handicapped are neglected by the general direction of transport policy and are barely acknowledged by the population. Transport measures that create conflict between handicapped and able-bodied people are politically impracticable. Moreover, handicapped people aim at re-integration into the society; and the concept of integration implies that measures which divided the population according to lines of interest should be avoided as well as any other division.

Dutch disabled find themselves faced with the task of designing a form of transport, preferably one not more expensive than public transport, and in other ways agreeable to the public and the administration. Recently published studies in the Netherlands have made obvious that making public transport accessible to handicapped travellers, including wheelchair users will be more auspicious than providing parallel paratransit services. These studies have started from the assumption of not adapting existing stock, which was designed to serve the accessibility demands of the able-bodied only, but of the gradual introduction of a new generation of vehicles designed to be suitable for all citizens.

A crucial element of the proposed re-designed public transport was a hydraulically kneeling bus, that is lowered at a bus stop to almost street level in a few seconds. This type of bus enables a considerable decrease of boarding time for the average passenger. Moreover it can carry more passengers than a conventional bus of the same dimensions since it does not contain an entry section with steps. The calculated cost of purchase of this 'completely accessible bus' exceeds that of a conventional one; the calculated cost of operation does not.

The Dutch parliament unanimously urged the construction and operational test of a number of these accessible buses. The administration, however, rejected the idea, resulting in a political deadlock.

Editorial Note

The views expressed by the writer are personal, as is his interpretation of the developments reported.

D.A. Vogelzang, Dutch Council of the Disabled, Postbus 323, 3500 AH Utrecht, The Netherlands.

PROVIDING ACCESS FOR THE DISABLED TO PUBLIC TRANSPORT FACILITIES AND BUILDINGS—ROLE OF THE SWEDISH BOARD OF TRANSPORT

Bengt Finnveden

Introduction

In connection with the transport policy mandated in 1979 a new authority, the Swedish Board of Transport, was established to deal with questions concerning overall transport planning. Of special interest is the adaptation of public transport to the needs of disabled persons.

The Board of Transport was assigned a coordinative responsibility which includes the planning, the initiation and the follow-up of this adaptation. The Board's coordinative role is expressed through the issuing of directives that are binding on transport enterprises and supervisory authorities, on these forms of transport:

- buses
- locomotive-hauled carriages
- trams
- underground railway carriages
- vessels
- motorcoach trains
- commuter trains

The directives for new buses, locomotive-hauled carriages, trams, underground railway carriages and vessels came into force on January 1, 1984. For new motorcoach trains and commuter trains the directives are effective January 1, 1985.

Decision by Parliament

The political background is a decision made by the Parliament of Sweden in 1979. Parliament indicated the adaptation process should be completed in a period of about 10 years. It is essential that the adaptive measures be realized gradually and in a way that is reasonable with regard to technical and financial conditions.

As regards disabled persons the 1979 decision on a new traffic policy resulted in the following laws:

- a new Act (1979:559), Facilities for the Disabled on Public Transport
- a new Ordinance (1980:398) on facilities for the disabled on public transport
- an amendment to the building regulations

In accordance with the 1979 Act all public transport vehicles shall, as far as possible, be suitable for disabled travelers. The act defines public transport as conveyance of passengers offered to the public for remuneration and scheduled according to a time-table or as taxi traffic. When public transportation is planned, the special needs of disabled persons shall be taken into consideration to the extent possible. Supervisors of public transport and those who carry out such transport must assure its suitability for disabled persons.

The Ordinance (1980:398) on facilities for the disabled on public transport states that the Swedish Board of Transport (TPR) shall initiate, plan, follow up, and coordinate the adaptation measures. The Swedish Board of Transport shall also issue directives concerning the nature and extent of the adaptation. The Swedish State Railways, the National Road Administration, the Swedish Road Safety Office, the National Administration of Shipping and Navigation and the Board of Civil Aviation shall, within their respective fields, issue further directives with regard to construction, equipment and operation of the vehicles.

With the consent of the Government, the Swedish Board of Transport issued a proclamation on January 11, 1982 (TPRFS 1982:01) concerning facilites for the disabled on public transport, on the provision of facilities on buses, locomotive-hauled carriages, trams, underground railway carriages and vessels.

After consultation with representatives of disabled persons, traffic operators, vehicle manufacturers, authorities, etc., and with approval by the Government, the Swedish Board of Transport issued regulations for motorcoach and commuter trains in September 1983.

Principles of New Regulations

In the Board's directives a distinction is made between vehicles already in use or planned for delivery before the end of 1983 and "new vehicles," so demands on adaptation of older vehicles were not as extensive as those for the new generation of rolling stock. For obvious reasons it would be unrealistic to demand from the operators that a bus or an underground railway carriage should be extensively retrofitted at a high cost when its remaining life time is limited. On the other hand the extra cost for making a new vehicle better fitted for disabled persons is comparatively small if the adaptive measures are planned from the outset. It is estimated that the extra cost is about 1 percent of the total cost of the vehicle, as an average. The percentage is higher for railway carriages.

In the directives a distinction is also made according to various groups of disabilities. It is estimated that about 1 million persons or about 12 percent of the population in Sweden have ambulatory difficulties with public transport. The number of persons with different disabilities are:

- persons with walking difficulties, 400,000
- persons in wheelchairs, 30,000
- persons with visual impairment, 70,000
- persons with hearing impairment, 400,000
- persons with allergy problems, 100,000

Directives for New Buses

The directives deal with various elements according to a logical sequence;

a. extensive details such as where the vehicle is going (route number, destination sign)

b. entrance to the vehicle (height of steps, handrails for support)

c. interior of the vehicle such as support handles, seats, space for wheelchair, signalling device for alighting

d. additional information inside the vehicle

e. ventilation

f. illumination

g. flooring

h. measures for allergic persons

Buses

The directives for new buses include rules for the indication of route number and/or destination signs, announcing of designated stops and signalling devices for alighting. It is important that the figures and letters shall be easily legible and in contrasting colours. For figures at the front of the bus a minimum height of 200 mm has been prescribed.

Bus Entry

In at least one doorway of new buses equipped for more than 19 seated passengers, the height of the first step above the roadway is not to exceed 200 mm. This step may be of folding type. Furthermore, step treads and risers shall be so executed, or equipped with such devices as to facilitate the mobility of disabled persons and afford safety with regard to height, depth, foothold, illumination and colour.

Bus Interior

The space required for a wheelchair has been used as a norm for measuring accessibility in buses, but there is no definite requirement that a bus in urban areas should be adapted to accommodate a wheelchair. However, on buses intended for non-urban traffic the rear and/or center door must allow a clear passage of at least 750 mm. Such buses shall also have room for the installation of a wheelchair lift and provide room for a wheelchair passenger to ride on the bus while sitting in his wheelchair. Directives on the interior of the bus include: installation of support handles, number and placement of seats intended and marked for disabled persons, antiskid flooring material and intensity of illumination.

Special Conditions for Persons with Allergies

Since there are many persons who suffer from allergic reactions if they come in contact with furred animals or certain materials, the directives also deal with measures for allergic persons. Thus, the ventilation system shall allow at least 12 air changes per hour and furnishings in the bus shall, as far as possible, be made from non-allergenic materials. Furthermore, passengers with allergy problems are assigned to the front part of the bus by means of a notice or in some other manner, while passengers who are accompanied by a furred animal are directed to a seat in the rear of the bus.

Summary

In its work with the adaptation of public transport, the Swedish Board of Transport has primarily concentrated on such measures that are comparatively easy to accomplish which will facilitate travel for as many disabled persons as possible. However, adaptive measures that for technical reasons are not possible to carry through at present are subjected to intensified research and development. This applies primarily to further development of technical equipment such as a better transport chair or varous kinds of lifting devices to make it possible for wheelchairs to board different vehicles.

Bengt Finnveden, Bureau Chief, Swedish Board of Transport, Box 1339, 171 37, Solna, Sweden.

40

THE ROLE OF THE BRITISH DEPARTMENT OF TRANSPORT IN PUBLIC TRANSPORT FOR DISABLED PEOPLE

C. G. B. Mitchell and Ann Frye

Introduction

In Britain the Department of Transport, as part of central government, has been actively seeking ways of improving all types of transport for disabled people. Since the Department does not itself operate transport services these improvements have been achieved by providing information to disabled people, by identifying and publicising mobility problems, by providing technical information, and by encouraging the providers of transport services to use suitable vehicles, to build accessible infrastructure and to operate services that are suitable for disabled people. This paper reviews these activities, particularly with regard to public transport.

All the Department of Transport's work in the disability field is based on the firm belief that discussion and consultation with disabled people is vital at every stage of every project. This fundamental distinction of working with disabled people rather than for them is one which is believed to be essential if progress is to be sensibly conceived and well directed.

Consultation operates at every level of our activities At the top is a panel of advisers on disability appointed by, and working personally with, the Minister. This group of 12 people, all of them experts in particular aspects of disability and/or transport, and the majority of them disabled people, meet formally 2 or 3 times a year with the Minister to guide the Department on its future strategy and programme and to consider the broad outline of future policies. At an individual level these same people are called upon regularly on a day-to-day working basis to guide and advise on specific projects.

On each of the research projects operating in this area, a steering group meets regularly to monitor the progress and to guide and advise on the direction of the project. Each steering group includes a number of disabled 'consumers' whose views are of prime importance to the direction of the work.

Identifying Requirements and Providing Information

Surveys of Disabled People

In 1976 the Department's Transport and Road Research Laboratory (TRRL) commissioned two surveys of travel by elderly and disabled people. One, a survey of travel by registered disabled people in the City of Coventry, still provides the best information on this topic in Britain (Feeney et al., 1979). In it 166 physically handicapped people from two districts of the city who had been out in the past two months were interviewed at length about their travel by all forms of transport and the difficulties they experienced. A further 29 disabled people who were housebound were also interviewed to discover what aspects of their disability prevented them usng the different forms of transport. This survey showed that most disabled people who were not homebound were getting out as frequently as several times a week. Over 85 percent of them made trips on foot and by car or invalid tricycle, but only half used buses; a quarter used taxis and 10 percent used trains. Operational as well as vehicle design orientated factors caused difficulties, particularly in the use of bus services; (buses moving off before passengers were seated, or stopping too far from the curb). Many people were unaware of special facilities for disabled people where these existed.

The second survey, of the mobility of 647 retired but active old people in Guildford, covered similar topics and also peoples' requirements for access to friends, services and shops (Hopkin et al., 1978). It showed the importance of car ownership on travel, through only the minority of old people lived in households with cars. Walking was the most common means of travel. The 44 percent of the sample who had physical difficulty with walking, walked more and used buses less than those without such difficulty. Problems with buses found in Coventry for the more disabled people were also found in Guildford. The study also showed how poor health, low income, living alone and living in public housing on the outskirts of the city combined to cause problems with mobility and access to friends and services. (See Table 1.)

TABLE 1

Percentage of people experiencing difficulty with buses

Aspect of Bus Journey	*Disabled people who use buses*	*Elderly people with walking difficulty*	*Elderly people without walking difficulty*	*Housewives*
Getting to bus stop	49	8	7	3
Waiting at bus stop	51	4	5	2
Getting on and off	79	27	11	9
Travelling	90	9	3	4
Other aspects of service	—	16	17	24
All difficulties with design	—	40	22	20
All difficulties (design and service)	90+	56	39	44

SOURCE: Feeney et al, 1979; Hopkin et al, 1978

TABLE 2

Estimated disabled population of Britain (1968)

By mobility	*Number*	*Percent*	*By types of aid used*	*Number*	*Percent*
Can get out alone, without aids	1,630,000	(53)	No aid	2,140,000	(70)
			1 stick, calipers, special shoes	730,000	(24)
Can get out alone, with aids	700,000	(23)	Walking frame, crutches, 2 sticks	250,000	(8)
Can get out, accompanied	330,000	(11)			
Housebound	320,000	(10)	Wheelchair	120,000	(4)
Chairfast/bedfast	90,000	(3)	Other	30,000	(1)
Total impaired	3,070,000	(100)	Some people use more than one type of aid		

SOURCE: Harris, 1971

An earlier national survey of disabled people showed that in 1968 about 58 percent of disabled people were aged 65 and over (Harris, 1971). The most common causes of disability were rheumatism and arthritis, which were suffered by more than 25 percent of disabled people. Harris estimated that about 6 percent of the total population were disabled in some respect, but that only a third of these people needed to use an aid or to be accompanied to get about. Only about 4 percent of disabled people used a wheelchair, and about half of these people were able to walk a little if necessary. (see Table 2.)

In the run-up to the International Year of Disabled People the Department held a number of seminars for disabled people and the providers of transport services under the title 'Transport without Handicap' (Department of Transport, 1981). These identified a large number of ways in which transport services could be improved for disabled people, often at little cost, and have been the starting point of many subsequent initiatives.

Provision of Information and Advice

The belief in working with rather than for disabled people extends into the sharing and dissemination of information. One of the biggest problems in this area of work is that a large number of people in need of information, advice or guidance are, by definition, those people to whom it is least readily available. It is very easy to make contact with well informed, well connected, articulate disabled people but it must never be forgotten that the majority of disabled people are frail and elderly and often housebound. The Department has concentrated on trying to get advice and information spread right across the disability spectrum through the representative organizations and through individual disabled people.

This is done in a variety of ways. At one end of the scale the Department mounts exhibitions and produces films and videos on a variety of topics which are made available free of charge to any group or organization or individuals anywhere in the country who might want to make use of them. Our current programme includes a touring exhibition on problems and prospects in the development of public transport for disabled people which carries with it a large supply of leaflets and booklets from transport operators and others giving information about the services and facilities available. We have also produced a video on dial-a-ride services for disabled people which has been sent out on loan to groups and clubs across the country.

Magazine and newspaper articles are obviously another important and useful way of spreading information and this, too, is a high priority for the Department; so too is the running of seminars. The formula we have adopted in the past which produces the most valuable interchange of views and experience is to bring together the transport-providers, operators, designers and manufacturers with disabled-consumers—or would be consumers. This may seem elementary, but communication at this level between the 'providers' and 'consumers' has not always in the past been a reality.

One effective means of reaching a very great number of people is through the Department's Driver and Vehicle Licensing System. Through regular tax and licensing reminders sent out to 23 million people we are able to include information leaflets giving contact points or more specific information on a variety of disability matters. One recent example, a leaflet sent out in this way which gives a point of contact for information on any aspect of vehicles or driving for disabled people, is producing an average of 6-12 letters every day from disabled people wanting information on a wide range of transport and disability matters.

For the International Year of Disabled People the Department also undertook to write a national guide on transport for disabled people, as the previous surveys had found that many disabled people did not know about services that were already available to them. It rapidly became clear that it was not possible to provide a detailed catalogue of local transport services for disabled people throughout Britain, so the first part of the Guide, called 'Door to Door', concentrated on detailing services, concessions and financial entitlements that were available nationally (Department of Transport, 1982); on describing the types of services provided locally by local public transport operators, by local authorities (county and district councils), by health authorities and by voluntary organizations; and on explaining exactly how to find out what services were available in any particular area. About 800,000 copies of Door to Door have been distributed free to disabled people and their helpers. A second part of the national guide was a document giving advice to local authorities and voluntary organizations on how to prepare guides to local transport services for particular areas: many such guides have now been produced (Department of Transport, 1983). The third part of the national guide, which is still in draft, is for transport providers and reports in detail on the difficulties disabled people experience, the ways they suggest these can be overcome, what solutions have been tried and how cost-effective they have been.

Local Bus Services

In general, the policy of bus operators in Britain has been to use vehicles that are designed to be as accessible as possible to elderly and ambulatory disabled people, to make low cost modifications to the vehicles as necessary, and not to attempt to carry wheelchair-bound people on general bus services routinely. Wheelchair passengers have been carried by local authority social services vehicles, by voluntary organizations and by the many dial-a-ride services that have started since 1980. Recently a number of bus operators have converted full size buses to carry wheelchairs. Some of these are used only for private hire journeys, but a number are being used to run special scheduled services chosen to serve areas where an above average number of disabled people live.

Fare Concessions

In Britain local bus services are provided by a mixture of private companies, subsidaries of the National Bus Company, municipal operators, departments of the local town governments passenger transport executives, public operators covering the areas of the larger cities, and London Transport. In all cases the policy for allowing fares concessions to elderly and disabled people rests with the appropriate local authority. Inevitably the level of concession provided varies from area to area. These variations are extreme, ranging from free off-peak travel in some of the larger cities, through areas with half-fare concessions or token schemes that provide a set budget of free travel, to the other extreme where some, mainly rural, areas that provide no concessions at all. It is not the role of the Department of Transport to standardize these schemes, but it has surveyed them and publicized the range of schemes (McTavish and Mullen, 1977).

Design of Buses For Ambulatory Disabled People

Between 1972 and 1980, Leyland Vehicles, under contract to TRRL, studied how the design of buses could be improved to make easier their use by elderly and disabled people (Brooks et al., 1974; Brooks et al., 1980). For an arbitrary sample of such people, Leyland Vehicles established the proportion of people who could get onto a bus with a given height of entrance step (Figure 1). They found that the design of the entrance handrail was of critical importance, and that rails such as the ones shown in Figure 2 significantly increased the height of a step that an elderly or disabled person could reach. The rails needed to be of large diameter (3.2 cm) and to be of a non-slip texture.

A study of the ride experienced by passengers during local bus journeys showed that maximum lateral accelerations were typically + 0.3 g and that fore and aft accelerations were in the same range (Brooks et al., 1980). Passengers' rating of ride quality was found to relate much more to the rate of change of acceleration (jerk, g sec-1) than to acceleration itself. Journeys rated subjectively as good involved fore and aft jerks of up to about 1.5 g sec-1, while journeys with higher jerks were rated bad. Fore and aft accelerations of 0.11 to 0.14 g required mild compensating motions by passengers, as did lateral accelerations of 0.23 to 0.25 g.

Measurements of the loads on stanchions and hand holds showed that in a normal bus journey a fore and aft acceleration of 0.15 g can require a passenger to exert a force on a stanchion of 60-70 percent of the passenger's body weight. Ramping the floor to a relatively small angle can increase this force by 30 percent. During the trials instances occurred in which passengers exerted forces of 160 percent of their weight on stanchions.

A study was made of the accidents to passengers recorded by 30 bus operators over a period of 2 years. Of all accidents to passengers, 14 percent occurred in collisions, 29 percent while the bus was taking emergency actions and 57 percent during routine operations. (See Table 3.)

Twenty percent of accidents were with the bus stationary, 26 percent when it was moving off from a stop and 18 percent when it was slowing down. People aged over 60 were more likely to be involved in accidents than younger people and more likely to be involved in non-collision accidents. (In 1977 about 20 percent of bus passengers were over 60 years old.) (See Table 4.)

43

TABLE 3

Passenger casualties and bus action at the time of the accident

Bus Action	*Passenger Casualties*							
	In collisions		*In emergency action*		*In falls etc*		*Total*	
	n	%	*n*	%	*n*	%	*n*	%
Stationary	13	1	—	—	315	20	328	21
Moving off	39	2	97	6	253	16	389	26
Cruising	101	7	220	14	100	7	421	28
Slowing down	50	3	90	6	126	8	266	18
Stopping (final moment)	5	—	8	—	41	2	54	3
Reversing	—	—	4	—	13	—	17	1
Unknown	6	—	21	1	23	2	50	3
Total	214	14	440	29	871	57	1525	100

SOURCE: Brooks et al, 1980

TABLE 4

Ages of bus passenger casualties

Type of accident	*Age of passenger*							
	Under 60 years		*Over 60 years*		*Unknown*		*All ages (100%)*	
	n	%	*n*	%	*n*	%	*n*	%
Collision accidents	276	77	83	23	—	—	359	
Non-collision accidents	842	57	634	43	—	—	1476	
Collision—falls in bus	225	59	68	18	89	23	382	
Non-collision—falls in bus	572	47	439	36	194	16	1205	
Non-collision—falls to ground	114	46	98	39	37	15	249	
Boarding	92	43	123	57	—	—	215	
Alighting	229	57	173	43	—	—	402	
Trapped by doors	15	35	29	65	—	—	44	
Gangway accidents	176	51	171	49	—	—	347	

SOURCE: Brooks et al, 1980

The lessons of this work have been widely published and incorporated into the design of modern buses. To determine how effective the improved designs are in service TRRL has commissioned two studies by Cranfield Institute of Technology. These are reported by Oxley and Benwell in another paper at this conference, and are only summarized here. The first consisted of observing the use made, in normal operations, of double-deck buses with a very low fixed entrance step and of single-deck buses that could kneel to reduce the ehight of the entrance step (Oxley and Benwell, 1983). The second was to observe the ergonomic suitability for elderly and disabled people of four types of bus, to assess the operational implications of giving disabled people more time to board and alight, and to estimate the increase in ridership of having all buses as easy to use as the best.

The first study showed that the lower part of the fixed split-step entrance (Figure 3) was used preferentially by disabled and encumbered passengers. Boarding time was the same for split-step and conventional entrances. Passengers who had difficulties boarding recognized that there were different types of entrance in service and found the split-step easier to use. Passengers found alighting (through a separate exit) more difficult than boarding, and they found moving within the bus to find a seat or to reach a bell-push the most difficult activity of all. The lower entrance steps cost little if any more to construct and no more to maintain than the conventional entrance.

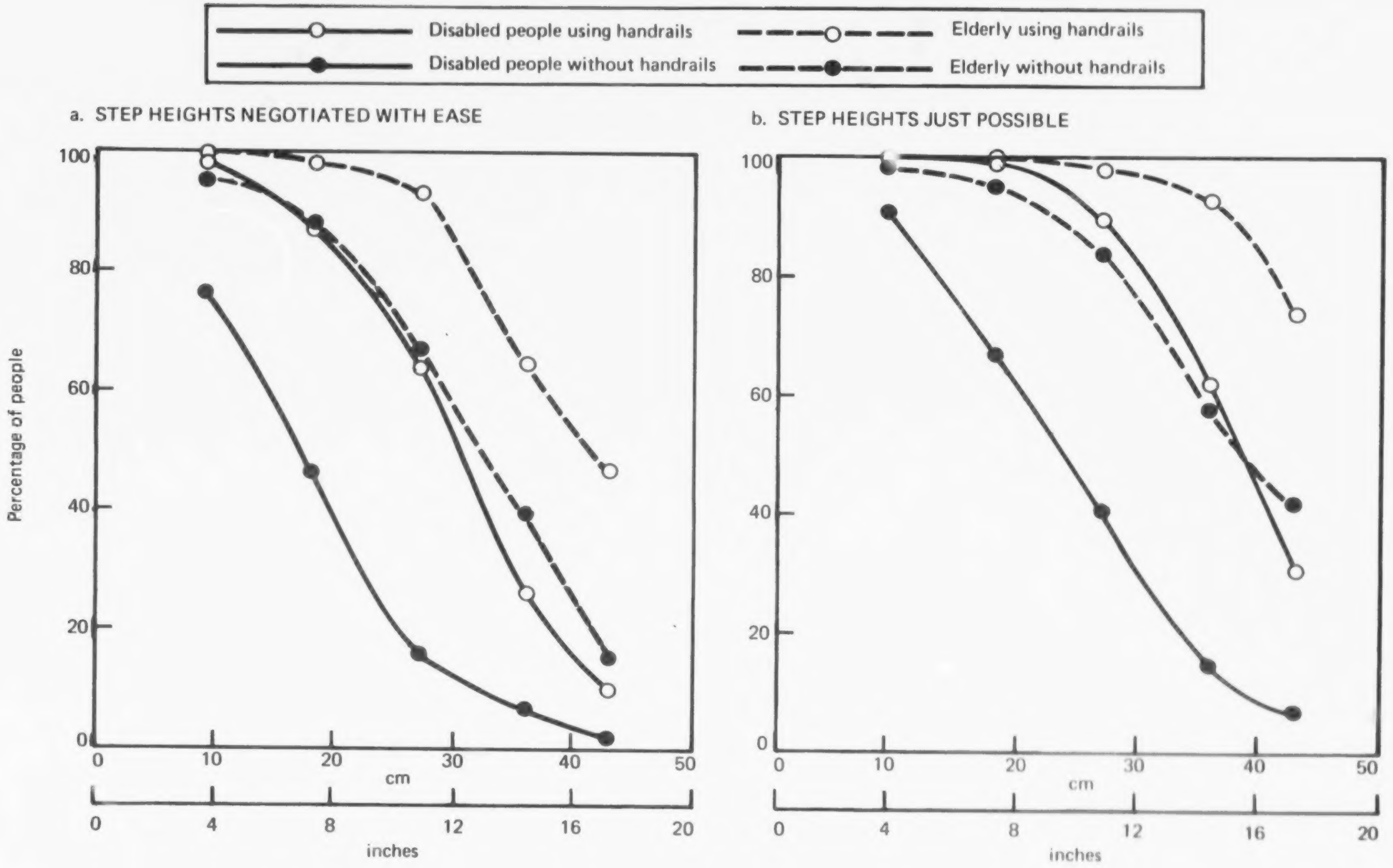
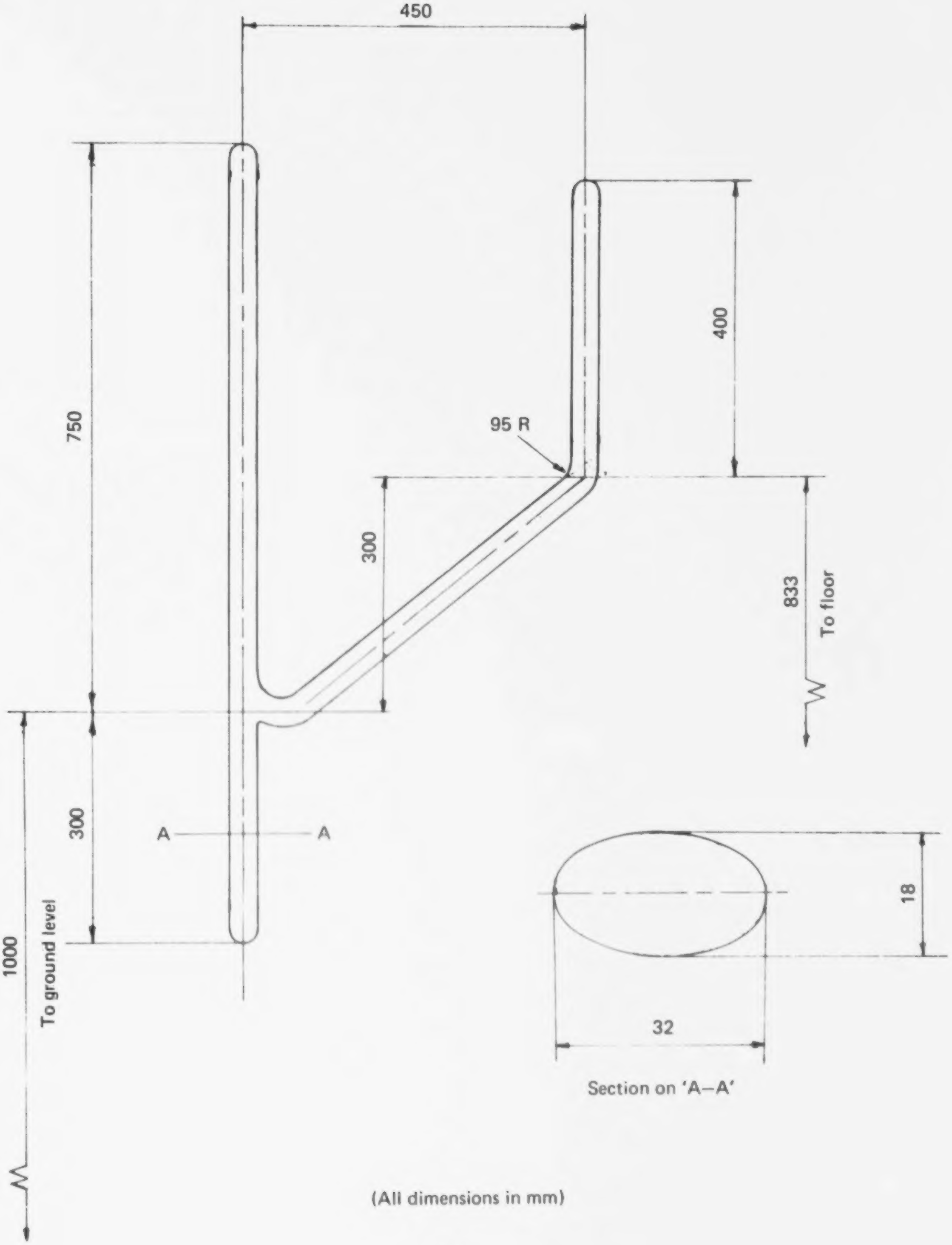
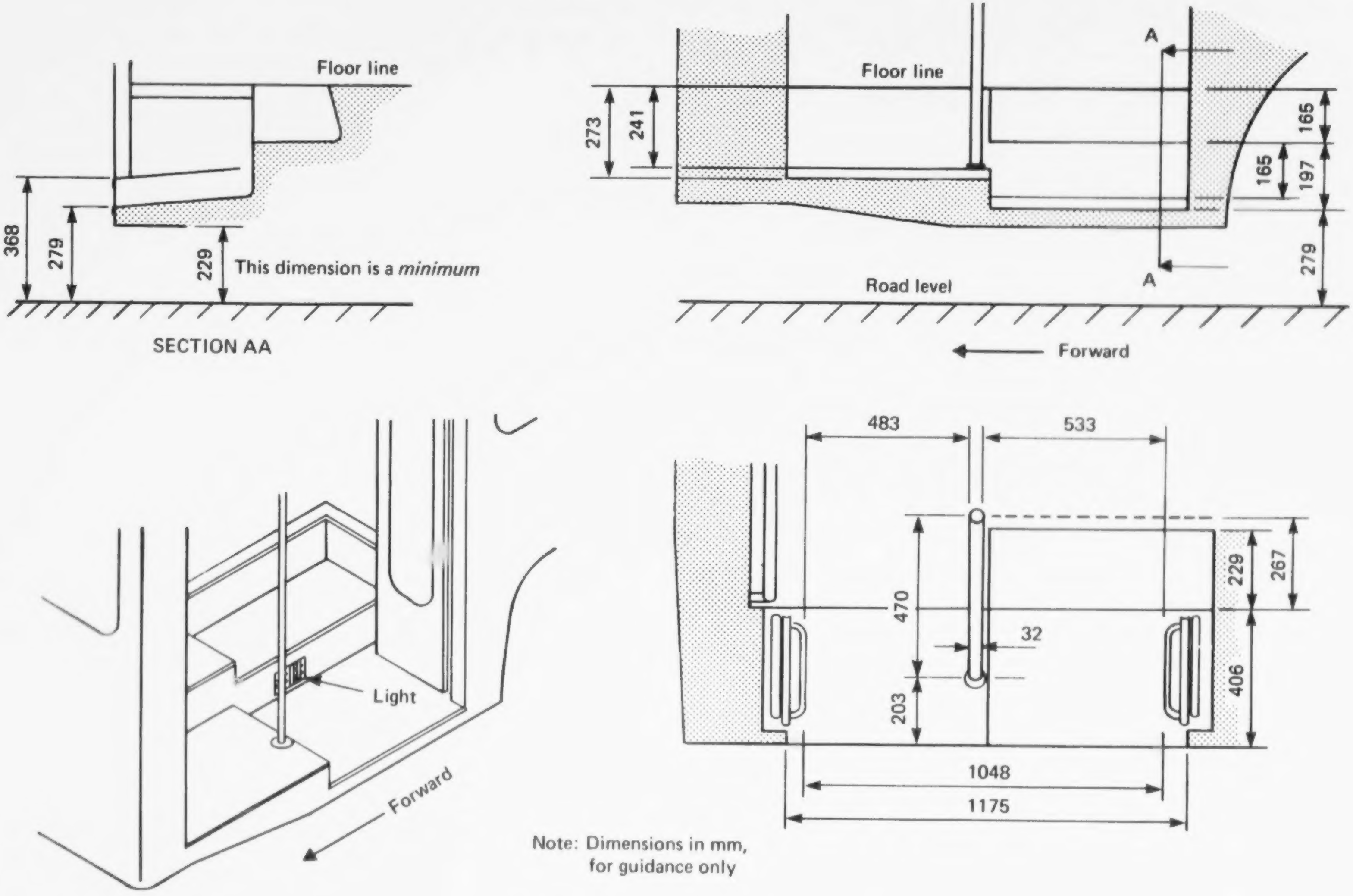


Fig. 1 Percentage of people able to negotiate bus entrance steps (from Brookes et al. 1974)



(All dimensions in mm)

Fig. 2 Recommended entry/exit handrail (source: Brooks et al, 1980)



Note: Dimensions in mm,
for guidance only

Based on drawings by SYPTE

Fig. 3 Layout of the split step entrance

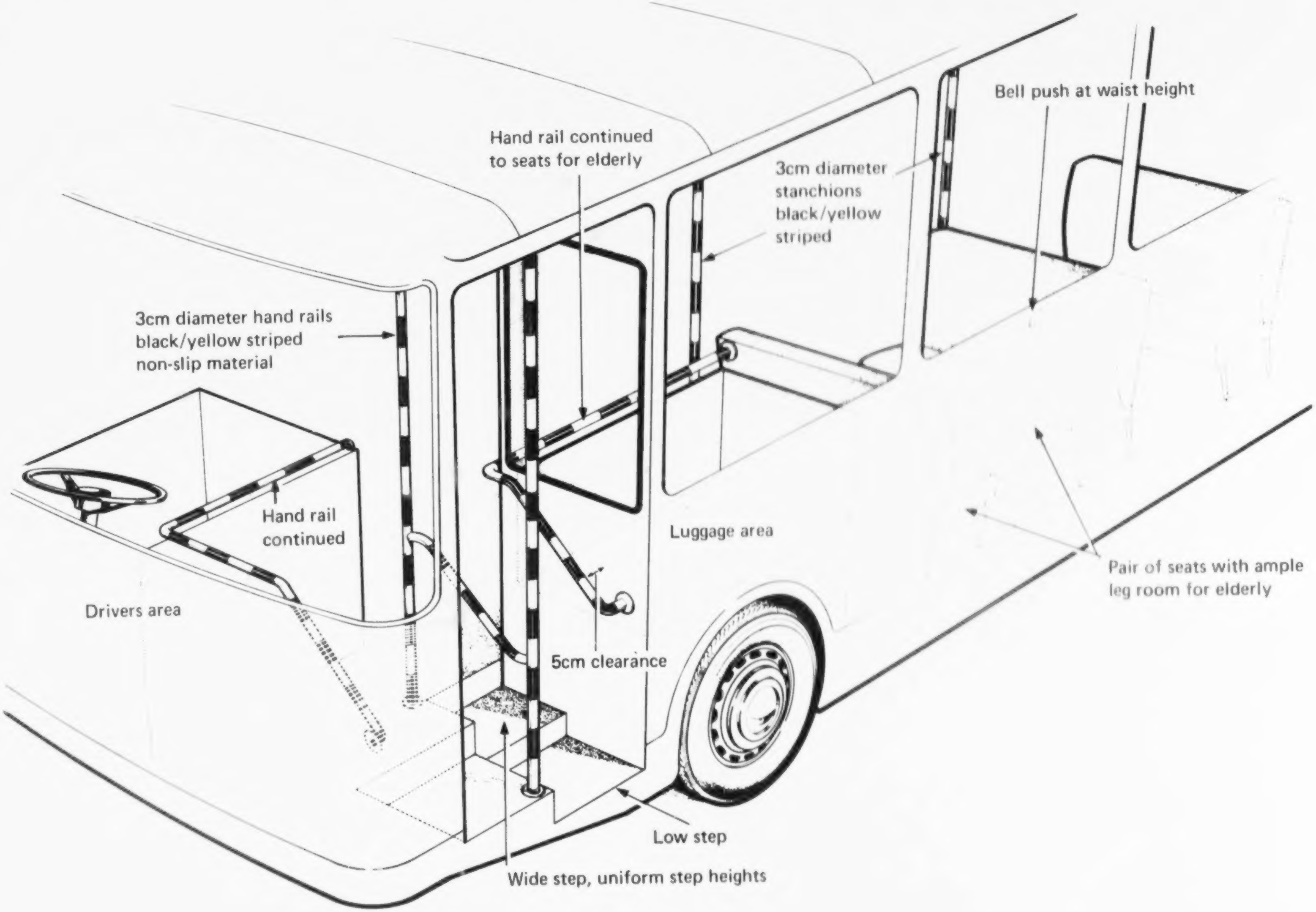


Fig. 4 Bus design — desirable ergonomic features (doors omitted)

the kneeling buses, on the other hand, did not benefit users because they were rarely knelt in practice.

The second study used a sample of disabled people chosen from a general random household study. This, and a National survey that asked similar questions (Official Population Census and Surveys, 1984), showed that some 9 percent of the population had something about their general health that made using buses difficult, about 2-3 percent were unable to use buses because of physical difficulties, and some 1½ percent used them less often than they would wish for this reason. The ergonomic trials using the four buses demonstrated many design features that were important for ambulatory disabled people. A step height of 20 cm was found to be a critical threshold, above which difficulties increased rapidly.

It was also found to be important for all steps in a flight to be of equal height, and for treads to be at least 35 cm deep. The importance of hand holds at the entrance was reiterated, as with the need to continue a horizontal rail at a height of about 85-90 cm continuously from the entrance to the seats reserved for disabled people. These should be a pair of forward and rearward facing seats with ample leg room between them. They should be provided with a bell push at waist height (see Figure 4). Mildly disabled people took little if any more time to board the bus, but the boarding time increased dramatically for severely disabled people. (Some people had stopped using buses because they felt they were delaying other passengers.) If the bus failed to get within 30 cm of the curb at a stop then the disabled people who had most difficulty climbing had to step down into the gutter to reach the bus. The time penalty of waiting at bus stops to allow all elderly and disabled passengers to get seated before the bus moved off was about 30 seconds on a 60 minute journey. If all buses were as well designed as the best and were operated to provide extra time at stops for disabled people to find a seat then bus ridership in Britain could be increased by 2 to 4 percent.

Assistance To People With Sensory Handicaps

Local bus services can present many problems to people who are blind or partially sighted, deaf or without speech. One experiment currently on trial in the United Kingdom (UK) has been developed by the Department of Transport specifically to help visually handicapped people with the problems of coping with bus timetables, finding the right bus stop and knowing which bus is approaching. The equipment, known as ELSIE (which stands for Electronic Speech Information Equipment) is, in effect, a "talking" bus stop. ELSIE uses speech synthesis techniques and micro-electronic sensing equipment to give information to passengers waiting at the bus stop about the buses which use that particular stop, the scheduled arrival time of the next bus on each route and it then identifies the number of each approaching bus at a distance of about 150 yards.

If the first trial is successful, the application of this technique is likely to be extended more widely across the country and to be developed to provide information in other ares such as on-bus announcements of approaching stops.

One valuable factor in this and other developments is that the same basic technique is increasingly being used by bus operators for bus detecting and scheduling. If an application to help disabled people can be seen as a relatively low cost spin off of this wider application its chances of being adopted by operators across the country is, of course, very much greater.

Another very simple device is in use with one operator which tells a blind person what type of bus they are boarding. This is a small plate on the entrance stanchion which is embossed with symbols to indicate if the bus has one door or two, is single or double deck, where the stairs are (if double-deck) and where the reserved seating is.

Much can be done by crew training, and operating staff in many bus companies are being taught how to communicate with passengers who have speech and hearing difficulties.

Wheelchairs On Buses

Since 1980 an increasing number of buses and coaches have been modified to make them accessible to people in wheelchairs. In the last two years scheduled services have been started using these vehicles. All but one of these are at low frequency on special routes chosen to suit disabled people. These services provide transport to the town centre and back one or two days a week, and allow a stay time of a few hours in the town centre. All the services carry an attendant. These services, which typically use up to 3 vehicles, are currently carrying 300 to 350 passengers a week. At least one of them, which provides 3 wheechair places per bus, has reached its capacity limiations. The operating cost per passenger on these services if typically 3 pounds sterling (about $4) for a one-way trip. (See Table 5.)

The Department of Transport has developed a Code of Practice for the carriage of wheelchairs on public service buses (Department of Transport, 1982). This covers the strength requirements for wheelchair anchorages, the size needed for doors for wheelchairs and the space needed to manoeuvre and locate a wheelchair. This code was much needed. Sledge tests of the strength of wheelchair anchorages have shown that under a 10 g deceleration (typical of that experienced in a bus during collision) many of the restraint systems then available failed (Petty and Chatfield, 1983). These have now been modified or withdrawn. At 15 g to 20 g (typical of the deceleration in a minibus or van during a collision) the wheelchair

TABLE 5

Wheelchair-accessible local bus services

Area	*Date started*	*Number of buses*	*Passengers per week*	*Lift or ramp users per week*	*Wheelchairs per week*	*Approximate cost per passenger* *
			URBAN AREAS			
Leicester City	Oct 82	3	360	180	70	£ 2.80
Doncaster	Aug 83	2	300	150	120	£ 2.30
Barnsley	Dec 83	2	250	140	80	£ 2.50
Plymouth City	Dec 83	1	150	—	—	£ 2.10
Strathclyde (Glasgow and surrounding area)	Sep 83	11 large 4 small	—	—	—	
Lymm (Cheshire)	mid-84	1 small	—	—	—	
			RURAL AREAS			
East Sussex	1983	1 midi	—	15	10	
Bassetlaw	1978	1	—	—	—	
Clydesdale	1983	1	—	—	6	

* Cost divided by total number of one-way passenger journeys, regardless of passenger disabilities. Amounts are in pounds Sterling.

itself may fail, though usually this happens in a way that would not injure the occupant provided the occupant is restrined. It is necessary for the anchorage for the chair and the restraint for the occupant to each have direct load paths to the vehicle structure, and for the floor to be strong enough; at 20 g the front castors of a wheelchair can push vertically through a 12 mm plywood floor.

Community Transport and Dial-A- Ride

Since about 1975 there has been, in the UK, widespread introduction of small scale transport services covered by the general title 'community transport.' These services attempt to identify unmet need at grass roots level. They provide, in the main, for elderly and disabled people. They start from the point of seeing what transport can facilitate in terms of opening up opportunities for independent living and broadening horizons.

The schemes are funded from a number of sources including local authorities, central government's Urban Aid programme (designed to improve services and facilities in deprived inner city areas) and voluntary organizations. At mid 1984 there were at least 600 such services running, the majority in urban areas. The operators of these services face many common problems over identifying unmet need and finding the most effective way of meeting it through type of system, choice of vehicles etc. In 1983 the Department of Transport set up a National Advisory Unit for Community Transport to provide expert advice on these and other topics.

Experiments with dial-a-ride for able bodied passenges were conducted in the mid 1970s, but this form of transport was abandoned for able bodied passengers because the high operational costs could not be justified on a subjective basis for that market.

Since 1980 an increasing number of dial-a-ride services for disabled people have been started and by mid 1984 about 100 services were running. These are typically small services with one or two vehicles carrying perhaps 100 passengers a week. It should be stressed however, that typical does not imply that these services can yet be regarded as entirely satisfactory. Most are still at a very ealy stage of development. Expertise in meeting the transport needs of elderly and disabled people in a sensible and cost effective way is only just beginning to be built up and we are still very much in the learning process. One of the larger systems, which TRLL have been monitoring closely for this purpose, is the Reading 'Readibus' system operating in the town of Reading where 4 minibuses are currently carrying about 350-400 passengers a week. One of the important lessons to be learned from Reading is the need to identify a sensible operating area around which boundaries can be set and to try to minimize empty running and other costs without leaving frail elderly people in a vehicle for 4 hours to cover a 2 mile journey! We are only now in the process of building up experience of how sensibly to combine good operating practice with the all important requirement of meeting need.

Taxis

Many ambulatory disabled people, and most people in wheelchairs, find it very difficult if not impossible to use the current London taxi. One consequence of this that was identified by the 'Transport without Handicap' seminars was that this makes it difficult for disabled people to use trains to or from the London termini, unless they can use a car to or from the railway station or airport in London.

In 1981 the manufacturers of the London taxi were designing its replacement, Code named CR6, and had considered making it accessible to people in wheelchairs. TRRL gave some advice on the necessary dimensions to achieve accessibility and purchased the first two prototype CR6s. These have been subjected to tests to determine their ergonomic suitability for disabled people and have been put into trial service for periods of a year at a time with five operators. These trials and tests have identified a number of desirable improvements which have been incorporated into the production vehicles.

The significance of the CR6, and or other wheelchair accessible taxis that seem likely to be produced is threefold. Fristly, in the areas where London-type taxis are used part of the public transport system will be accessible as a matter of course. In Britain this is likely to be the case in all cities of over ½ million population. Secondly, for the first time there will be an accessible transport network door to door between all the major cities. This is because the principal inter-city rail and air networks are accessible already, and need only an accessible mode for the first and last links of a journey. Thirdly, the taxi provides a small accessible vehicle which is likely to be suitable for social service transport, voluntary societies and individuals as well as for the taxi business.

Access to the CR6 is achieved by providing wide rear side doors, a flat floor and a space beside the driver in which a wheelchair bound passenger can travel facing rearwards. The chair and occupant are restrained by specially developed belts. A manually deployed ramp fits into the rear door aperture, but in practice a wheelchair can often be loaded from the curb without it. The features that make wheelchair access possible cost some 200 pounds sterling (around $300) per vehicle. However the extra production that seems likely to result from providing access is likely to reduce the unit cost of the basic vehicle by more than this, so access should be achieved at no cost.

One useful experiment recently extended London wide after a trial period in one or two smaller areas is the Taxicard scheme. Any Londoner who is unable to use conventional public transport because of a disability is entitled to a Taxicard which gives concessionary travel in a London taxi. The disabled person pays a 1 pound flat fare up to a limit of 6 pounds on the taxi meter. This scheme, which operates through a number of large radio controlled taxi circuits in the City, is able to provide a door to door, on demand, service for disabled people without the overheads incurred by dead mileage and the other problems of the specialized transport services. At the moment, the benefits of the scheme are limited by the design of the existing London taxi which can accommodate only those sufficiently agile to manage the high step and the awkward door. From late in 1985, however, the new generation of London taxis, fully accessible to wheelchair bound and other disabled people, will begin to come onto the streets and the viability of schemes like these will be greatly extended.

Pedestrians

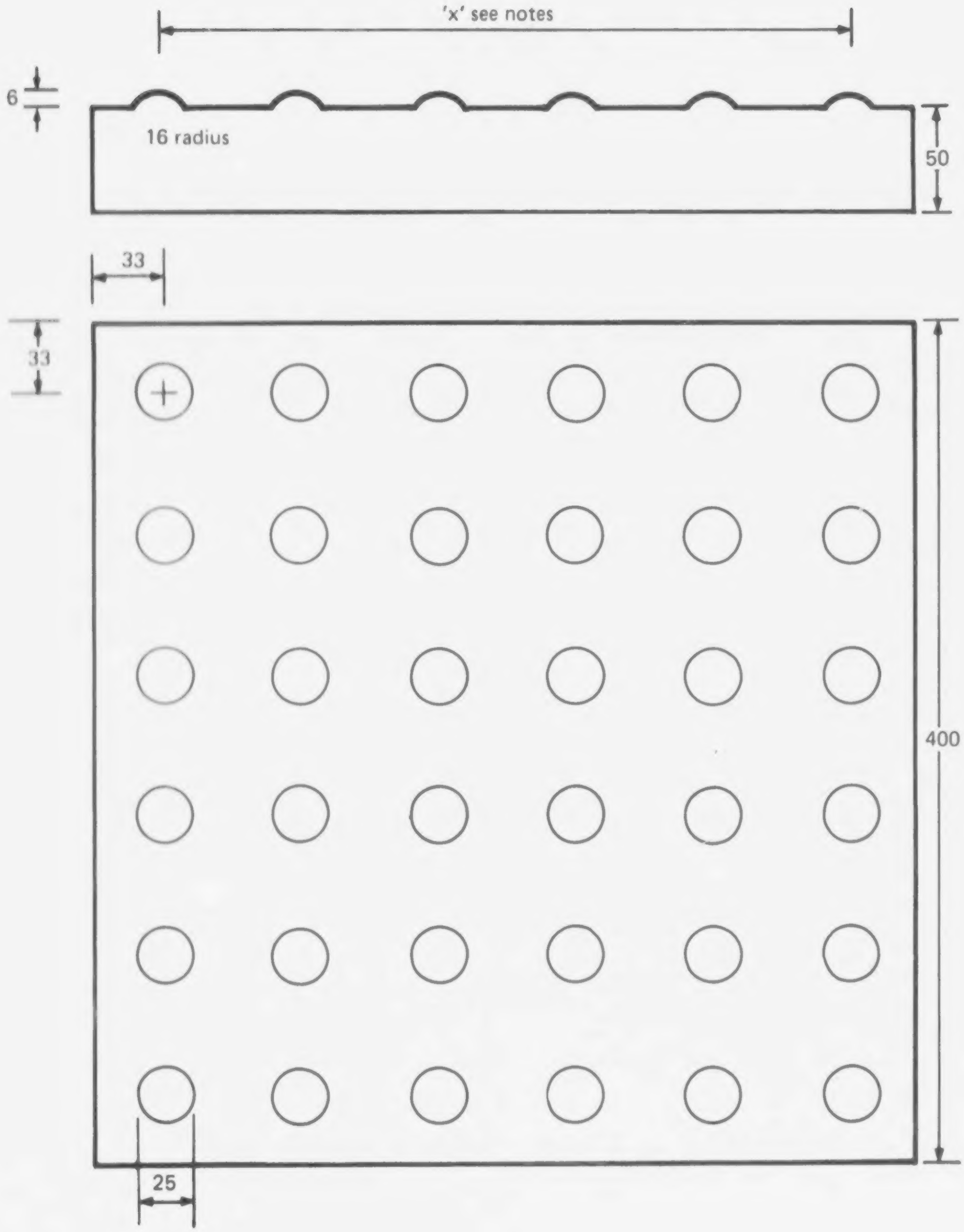
Many elderly and disabled people make most of their local journeys on foot. The surveys mentioned in an earlier section identified some of the aspects of walking that provided difficult for pedestrians (see Table 6; Hitchcock and Mitchell, 1984). Some tasks or features, such as crossing roads, narrow pavements and hills or ramps, were a source of difficulty for all pedestrians. Others, such as crowds and steps or curbs, were difficult only for the more seriously disabled peple. There is at present no Departmental code of practice for the design of pedestrian areas, although some local authorities have their own design guidelines, but the nepartment is publicizing the causes of pedestrian problems.

There is in Britain a legal requirement to make new public buildings accessible to disabled people. To support these accessible buildings it is necessary to make the surrounding network of streets and footways (sidewalks) accessible, and an increasing number of local authorities are introducing ramped edges to footways at road junctions and pedestrian crossings. This causes a problem for blind or partially sighted people who use a cane to feel the sharp edge of a normal curb. To overcome this problem TRRL has developed a lumpy textured paving slab with which to surface footways adjacent to pedestrian crossings. The texture is large enough to be felt through shoes, and about a dozen designs were tried to find a surface that did not trip people or interfere with pushchairs for babies, shopping trolleys or wheelchairs (Figure 5). Examples of the textured pavement have been laid in a number of towns and their use and the reactions of the public to them are being monitored.

Private Transport

While this paper is concerned mainly with public transport, for completeness this section summarizes work on private transport.

In the mid-1970s TRRL developed a joystick-type low-force controller for cars for severely disabled people.



Notes

a. All dimensions in mm. Domes are sperical

b. Distance 'x' to be divided into five equal parts, giving a total of six rows of domes equally spaced

Fig. 5 **Textured surface designed to assist blind and partially-sighted people at pedestrian crossings**

TABLE 6

Difficulties in the pedestrian environment

Aspect of pedestrian environment	*Percentage of people reporting difficulty*				
	Registered disabled (%)	*Elderly physical difficulties with walking (%)*	*Non-elderly housewives, physical difficulties with walking (%)*	*Elderly no difficulty with walking (%)*	*Non-elderly Housewives, no difficulty with walking (%)*
Kerb	12	5	4	4	2
Steps	58				
Hills/ramps	59	45	30	19	12
Uneven/narrow pavements	21	19	13	14	8
Crowds	50	4	0	5	2
Traffic/crossing roads	35	31	22	16	17
No difficulties	2	23	43	54	67
Sample	143 disabled people in Coventry who made walk trips	366 from total sample of 825 in Guildford	23 from total sample of 195 housewives in Guildford	459 from total sample of 825 elderly in Guildford	172 from total sample of 195 housewives in Guildford
SOURCE:	Hopkin et al (1978, table 4)	Hopkin et al (1978, table 14)	unpublished	Hopkin et al (1978, table 14)	unpublished

With technology then available this controller was expensive, but it has been used quite extensively for people damaged by thalidomide. More recently TRRL has funded a study of the features of production cars that cause access difficulties for disabled people, and a review of converted controls for disabled drivers.

Disabled drivers have great difficulty in choosing a car to buy, because it is rarely possible for them to test drive a variety of cars fitted with adapted controls, and often it is not possible even to try travelling in a variety of cars as a passenger. An even greater difficulty for disabled non drivers is that they cannot discover whether they can drive without buying a car and having it adapted, yet this expense is not worthwhile unless they know they will be able to learn to drive. In 1983 the Department of Transport held a 3-day motor show at TRRL at which a wide variety of types of car with adapted controls were available for trial on the TRRL research track. About 10,000 people attended and over 1,000 took test drives, accompanied by driving examiners. This 'Mobility Road Show' is to become a regular bi-annual event, and the Department of Transport is looking at the possibility of establishing a permanent driving centre for disabled drivers, at which converted cars will be available for test on an off-road track under the supervision of a driving examiner. One such centre which is already available through a charitable organization has demonstrated that the demand for such advice is large. (See Table 6.)

Conclusions

In the past decade the Department of Transport and TRRL have done much to improve the mobility of disabled people, both directly and by encouraging the providers of transport services and infrastructure. This has covered all the surface means of transport and has included the provision of information as well as the design of vehicles and infrastructure and the operation of services. The importance of providing services door-to-door has been appreciated, and the development of a taxi that is accessible promises to be a major step in the provision of an inter-connecting network of accessible door-to-door services within and between the larger urban areas using taxis, inter-city rail services and airlines. There are signs that disabled people are getting about much more, and that there is a new generation of young disabled people who are determined to lead full and active lives. Although much has already been done to improve the mobility of all disabled people, the successes to date highlight how much can be done and still needs to be done.

Acknowledgement

The work described in this paper forms part of the programmes of the Department of Transport and the Transport and Road Research Laboratory, and the paper is published by permission of the Director, TRRL,

Crown Copyright. The views expressed are not necessarily those of the TRRL or the Department of Transport. Extracts from the text may be published, except for commercial purposes, provided the source is acknowledged.

References

Brooks, B. M., H. P. Ruffell-Smith and Joan S. Ward. An investigation of factors affecting the use of buses by both elderly and ambulant disabled persons. Transport and Road Research Laboratory Contract Report, British Layland UK Ltd., 1974.

Department of Transport. Door to Door. A guide to transport for disabled people, 1982.

Department of Transport. Transport without handicap. Department of Transport, London, 1981.

Department of Transport. The Welsh Office (1977), Survey of concessionary bus fares for the elderly, blind and disabled in England and Wales. Local Transport Note: 1/77.

Department of Transport. Code of Practice and special provisions for the carriage of passengers in wheelchairs on public service vehicles. Publication VSE 518. Vehicle Standards and Engineering division, London, 1982.

Department of Transport. Transport for disabled people. An introduction to local guides, 1983.

Feeney, R. J., N. J. Ashford, Anne Morris and D. Gazely. Travel and the handicapped: a project summary. (Loughborough University of Technology) TRRL SR 480. Transport and Road Research laboratory, Crowthorne, Berks, 1979.

Harris, Amelia I., Elizabeth Cox and C. R. W. Smith. Handicapped and impaired in Great Britain. Office of Population Censuses and Surveys, Social Survey Division, 1978.

Hitchcock, A., and C. G. B. Mitchell. Man and his transport behaviour, Part 2a, Walking as a means of transport. Transport Reviews 1984 Vol. 4, No. 2, 177-187. Presented to World Conference on Transport Research 1983, 1984.

Hopkin, Jean, M. P. Robson and S. W. Town. The mobility of old people: a study in Guildford. Transport and Road Research Laboratory, TRRL LR 850, 1978.

Leyland Vehicles Ltd. in association with Motor Industry Research Asociation. Passenger problems on moving buses. Transport and Road Research Laboratory SR 520, 1980.

Office of Population Censuses and Surveys, Social Survey Division. General Household Survey 1982. London HMSO, 1984.

Oxley, P. R. and M. Benwell. The use of buses in Sheffield by elderly and handicapped people. Transport and Road Research Laboratory SR 779, 1983.

Petty, S. P. F. (Vehicle Safety Division) and A. G. Chatfield (Vehicle Standards and Engineering Division DTp)). Static and dynamic tests of wheelchair restraints for use in public service vehicles. Transport and Road Research Laboratory LR 1087, 1983.

C. G. B. Mitchell, Vehicle Engineering Division, Transport and Road Research Laboratory. Crowthorne, England, RG116AV. Ann Frye, Transport Policy Review Unit, Department of Transport, London, SW1 England.

THE DIRECTION OF NATIONAL DEVELOPMENTS IN SPECIALIZED TRANSPORTATION IN THE UNITED STATES

William G. Bell and Joseph S. Revis

Introduction

This paper is the third of its kind developed for a series of international conferences on mobility and transport for elderly and handicapped persons. As the third in a sequence of overview papers, it can be viewed as a companion to the paper prepared for the second international conference in 1981 (Bell 1982) and the manuscript prepared for the first international conference in 1978 (Revis 1978).

In preparing an overview paper on one country there is a tendency to compare the approaches and orientation of other countries with similar interests. In addressing the mobility needs of the transportation disadvantaged, the U.S. gives emphasis to two groups in particular, elderly and the handicapped persons, more or less on a co-equal basis. This dual trend arose, in major part it is believed, by reason of the language in the so-called Biaggi amendment in 1971, Section 16 (a) of the Urban Mass Transportation Act which declared it to be national policy that elderly and handicapped have the same right as others to have access to mass transit facilities utilizing federal funds. An integration of elderly and handicapped persons in specialized transportation policies in the U.S. is not widely replicated; for example, in Canada and European countries physically handicapped people are the primary focus of national policy, and age, per se, is deemed not relevant, though the elderly, by no means are ignored.

In this context it is worth noting that no other country has the equivilent of a U.S. Administration on Aging with its substantive policy making responsibility and its advocacy role on behalf of the elderly. It seems appropriate, therefore, in this overview of U.S. developments to highlight the elderly in contrast to a strong orientation to the physically handicapped incorporated in most national overviews offered at this international meeting.

Background

As the U.S. entered the decade of the 1980s there was in place a substantial infrastructure capable of delivering a significant volume of specialized services to transport the elderly and other transportation disadvantaged groups. One study prepared for the U.S. Administration on Aging (AoA) estimated that between 2800 and 3000 local transportation programs for the elderly were being funded under Title III of the Older Americans Act. (U.S. Administration on Aging, 1980). That estimate did not include specialized transportation programs for which primary funding was provided by other major federal sources such as Section 18 of the Surface Transportation Assistance Act, Section 16(b)(2) of the Urban Mass Transportation Act and transport services funded with the assistance of Title XIX (and XX) of the Social Security Act. Nor does the estimated number of specialized programs funded by AoA include other local programs such as those offered by public transit agencies in the form of modified services for special groups, local paratransit services and service by private providers.

In early 1980 the arrival of a new administration in Washington coupled with other unrelated economic developments forecast a series of changes lay in store for the specialized transportation network. Some of these new influences were being felt in the early 1980s at state and local levels, others were to exercise their effect later. Among these major developments were the following:

- a stringency on national resources and a subsequent constraint on funding domestic public programs
- inflation and its effect on levels of service
- higher energy costs and its impact on operational budgets
- a more sustained effort to increase participation of the private sector
- a diminuation of effort within the U.S. DOT to enforce provisions of Section 504 of the Rehabilitation Act of 1973.[1]
- a stronger demand for use of volunteers as a cost cutting measure.

While inflationary effects and anticipated higher energy costs did not materialize with the intensity anticipated these higher costs exercised some early impact at the start of the decade.

---

[1] The Federal Register, Vol. 48, No. 175, September 8, 1983 proposed fresh regulations, under Section 504, specifying substantive and procedural requirements to assure nondiscrimination against the handcapped in the use of transportation funds. As of this writing, UMTA has not released the projected new regulations, and none are anticipated until late 1985 or early 1986.

National Investments in Specialized Transportation

Financial support for specialized transportation in the U.S. at the national level in the transportation sector, comes from the U.S. Department of Transportation (DOT); other national aid comes from a number of non-transportation agencies of which the dominant member is the Department of Health and Human Service (HHS) formerly the Department of Health, Education and Welfare (HEW). For example, a 1977 government study uncovered 114 federal agencies with some funds for transportation for special groups and 57 percent of these funding resources were located in HEW (GAO 1977).

Federal allocations for transportation for special groups are treated differently in the budgets of the transportation sector compared to the non-transportation sector budgets. These differences complicate extracting an accurate measurement of national funds allocated to specialized transportation. In the transportation sector the national appropriations in specific programs germane to elderly and handicapped persons are clearly identified. This is not the case in the broad field of human services transportation. In the case of the transportation sector, the funds are identifiable as they flow "from the top down", that is, as they move from national to state to local units. In the non-transportation sector the amount of funds used for transportation may come from the federal budget but the transportation specific funds are not easily identifiable because these funds tend to be buried, at lower levels, in diverse service programs where transportation is an allowable cost. Only when state and local expenditures are analyzed years after they have occured is it possible to derive estimates of what may have been spent on transportation; the cost estimates are derived from a process which may be characterized as "from the bottom up".

Four major sources of funding for elderly and handicapped transportation programs in the U.S. are:

1. Section 16(b)(2) of the Urban Mass Transportation Act (UMTA)

Provides grants covering capitol costs, such as purchase of vans, buses or equipment including wheelchair lifts. Allocations for the years 1980-85 are shown in Table 1.

2. Section 18, Surface Transportation Assistance Act (STAA)

Provides grants for rural public transportation for both capitol and operating costs. Receipents of grant awards are expected to give special attention to elderly and handicapped groups in their area. National funds made available to state and local agencies for fiscal years 1979-1985 are shown in Table 2.

TABLE 1

Funding Information—Section 16(b)(2) ($ millions) FY 1980-1985

Fiscal Year	*Section 3 Appropriations*	*Section 16(b)(2) Allowed Set-aside from Section 3 Appropriations*		*Section 16(b)(2) Actual Allocation from Section 3 Appropriations*	
		Percent	*Amount*	*Percent*	*Amount*
1980	$1,700	2.0%	$34.0	1.8%	$29.9
1981	2,190	2.0	43.8	1.1	23.6
1982	1,479	2.0	29.6	1.7	25.0
1983	1,692	2.0	33.8	1.5	25.0
1984	1,225	3.5	42.9	2.1	26.2
1985	1,120	3.5	39.2	2.3	26.2

SOURCE: Lenore Sek, "Department of Transportation Section 16(b)(2)". Economics Division, Congressional Research Service, Library of Congress. Washington, D.C. Unpublished document, no date.

TABLE 2

Section 18, Surface Transportation Assistance Act Available Funds ($ millions) FY 1979—FY 1985

Fiscal Year	*Available Funds*
1979-80	$75.0
1980-81	85.0
1981-82	72.5
1982-83	68.5
1983-84	91.3 *
1984-85	69.985
1985-86	72.7

* This amount includes additional funds from gas taxes.

SOURCE: M Caravetta, UMTA Section 18 Specialist, personal communication.

3. Older Americans Act of 1964 as Amended (OAA)

Transportation costs are extracted when annual expenditures under the Act from state and localities are reported under Title III (community services) and the former Title VII (nutrition programs). Estimated expenditures for both OAA programs for the years 1976-1979, the most recent available, are shown in Table 3.

A 1983 retrospective survey by the National Association of Area Agencies on Aging polled a randomly selected sample of one third or 222 of their 673 member Agencies with respect to their transportation expenditures from Title III funds for fiscal year 1982. Findings from the 151 Area Agencies on Aging responding to the survey indicated that slightly over 10 percent of the $263 million in Title III funds in 1982 were spent on local transport services for the aging. This estimate of local dollars addressed to local transportation for the aging is likely to be incomplete since it does not take into account financial support obtained from state agencies and private funding sources, though not all states contribute to operational costs of local specialized transit services.

TABLE 3

Older Americans Act Expenditures on Transportation, Title III and Title VII FY 1976-79

AoA Title III Program

Fiscal Year	*Total Program*	*Transportation*	*Transportation percent of Total*
1976	$ 60M	$ 8.5M	14%
1977	115M	16M	14%
1978	108M	18M	17%
1979	174M	29M	17%

AoA Title VII Program

Fiscal Year	*Total Program*	*Transportation*	*Transportation percent of Total*
1976	$112M	$ 5.7M	5%
1977	220M	11.3M	5%
1978	250M	12.5M	5%
1979	227M	13.8M	5%

Note: Transportation expenditures are reported to AoA under the Title III program. Under Title VII, transportation expenditures are not segregated, but grouped with other support services Overall for both programs (which have been legislatively consolidated under Title III) transportation costs are estimated at 81.6 percent of the combined total program expenditures.

SOURCE: Michael Albarelli, "Office of Human Development Services Transportation Service Expenditures Fiscal Year 1979". Office of Policy Development, OHDS, Washington, D.C. Unpublished document, no date.

4. The Social Security Act, Title IXX, (Medicaid)

Transportation for non-emergency health services are provided to the medically indigent. It is generally held that Medicaid-related transportation costs approximate or exceed those cited for the Older Americans Act, in Table 3, but nationally derived firm expenditures were not available, only estimates can be suggested.

National Investments Summarized.

In brief a review of the federal funding allocations with regard to Section 16(b)(2) and Section 18 suggest that under current national policy federal funding of transportation for the elderly and the handicapped is not likely to grow. They may, in fact, be reduced. Constraints on transportation funding generally in the U.S. DOT, suggest such resource stringency will continue over the next few years and probably over the remainder of the decade. Consequently prioritization of competing services will be inevitable at state and local levels to address the needs of special groups.

In view of the increasing limitations that may be anticipated in the availability of federal resources for transportation services affecting older Americans, the state and local response will become increasingly important. States will need to address two problems: 1) decisions on whether and how to balance financial constraints on federal funds which may have to be replaced or eliminated and 2) if replacement of federal funds is a feasible option, the extent to which the state or local tax and fiscal base can or is willing to support increased tax levels to maintain services, let alone expand them. It is likely that localities will be forced to find new sources of support, either from the private sector or from fees to replace the federal funding—or cut service. These developments will force prioritization, increased use of volunteers, a search for private funds and increased pressure on states to pick up some of the slack.

Beyond and above these fiscal and economic developments the future direction of specialized transportation is linked intrinsically to demographic changes associated with the population of aging persons in the U.S. Despite the mythology on the unchanging quality of the elderly, the demographic characteristics of older Americans are dynamic and changing rather than static and unyielding.

Demographics of the Aging—Changes Revealed by the 1980 U.S. Census

Data from the 1980 U.S. Census of Population affirmed a trend discernable with each succeeding Census, that is, the U.S. is moving steadily towards becoming an aging society. It is apparent that not only is the aging population increasing it is growing at a rate exeeding that of the general population. (U.S. Bureau of the Census, 1983). Analysis of the composition and other characteristics of older Americans in 1980 reveal significant differences with their 1970 counterparts. These will be cited in brief detail because of their implications for specialized transportation planning and developments in the immediate future.

1. Growth of the elderly population

Currently, a net of about 600,000 older Americans join the ranks of the elderly each year. As of 1980 elderly persons in the U.S. totalled about 25.5 million or 11.3 percent of the U.S. population, an increase of 27.4 percent in the past decade compared to a growth of 11.4 percent for the U.S. population as a whole. By 1985, the age group 65 years and over was estimated at 27.4 million; by 1990 it may rise to 30.4 million and constitute about 12.3 percent of the population

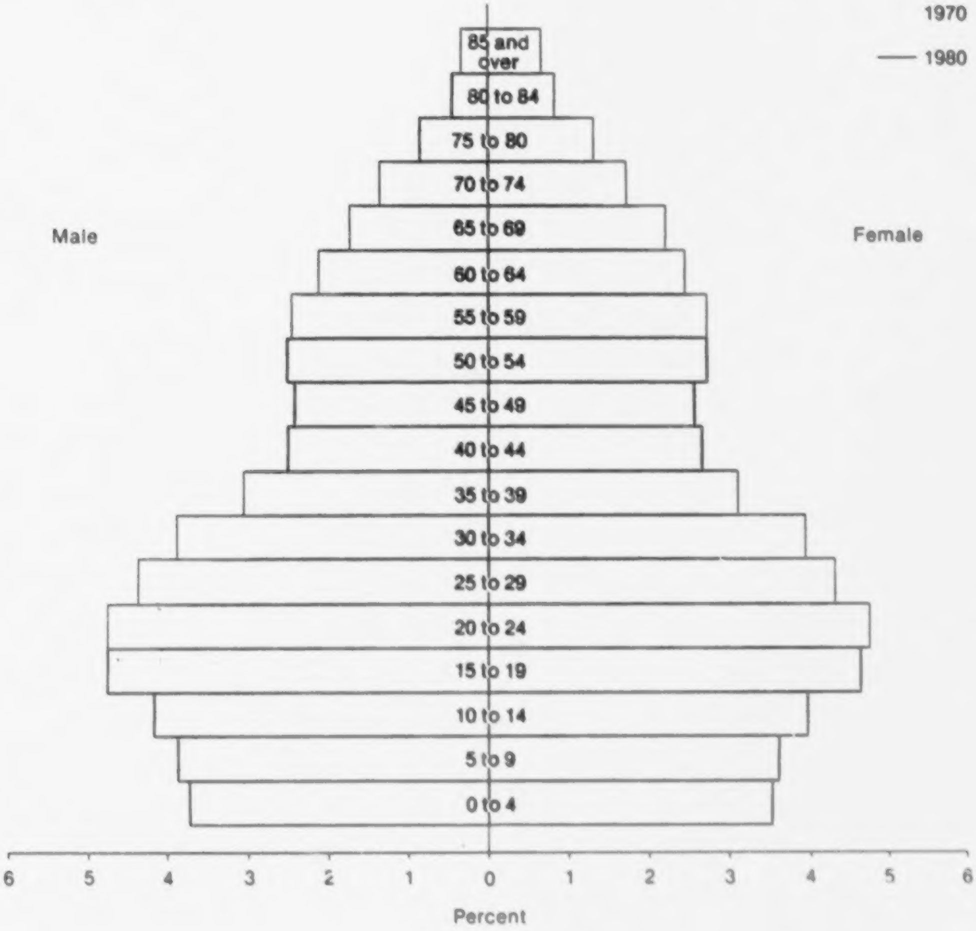
2. Structure of the aging population

An increasing survival rate displayed by elderly cohorts will, of course, bring in its wake a swelling of the aged population (see Figure 1); a rise in the number of chronically ill or frail elderly (see Figure 2); and an aging of the aged. That is, the 85 years and above group is growing faster than the 75 years and above group, and the 75 plus is increasing more rapidly than the population 65 years and over.

Figure 1

Percent Distribution of the Resident Population

by Age and Sex: April 1, 1980, and April 1, 1970



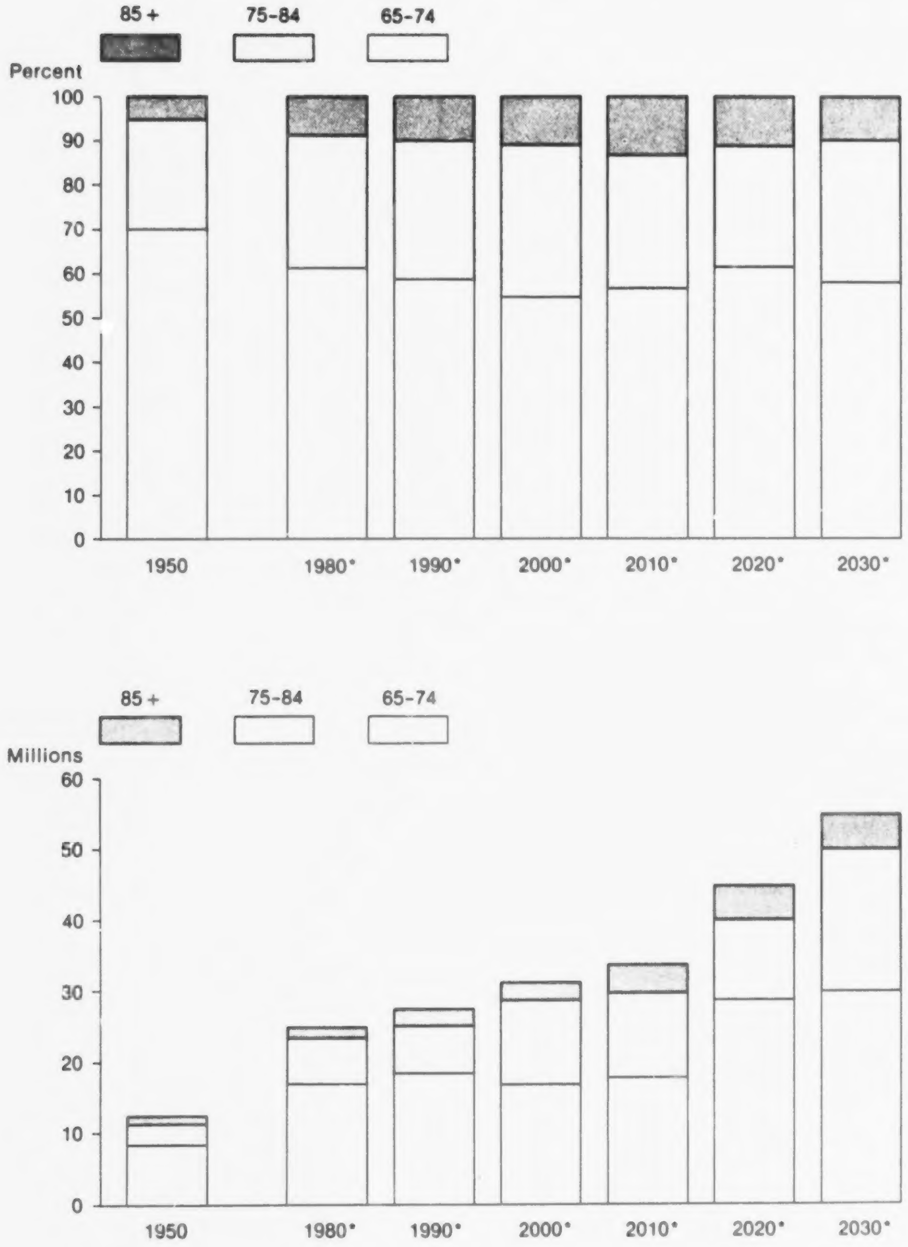
Source: 1980 and 1970 censuses.

61

Figure 2

Distribution of the Older Population

by Age Group, 1950 and 1980 to 2030



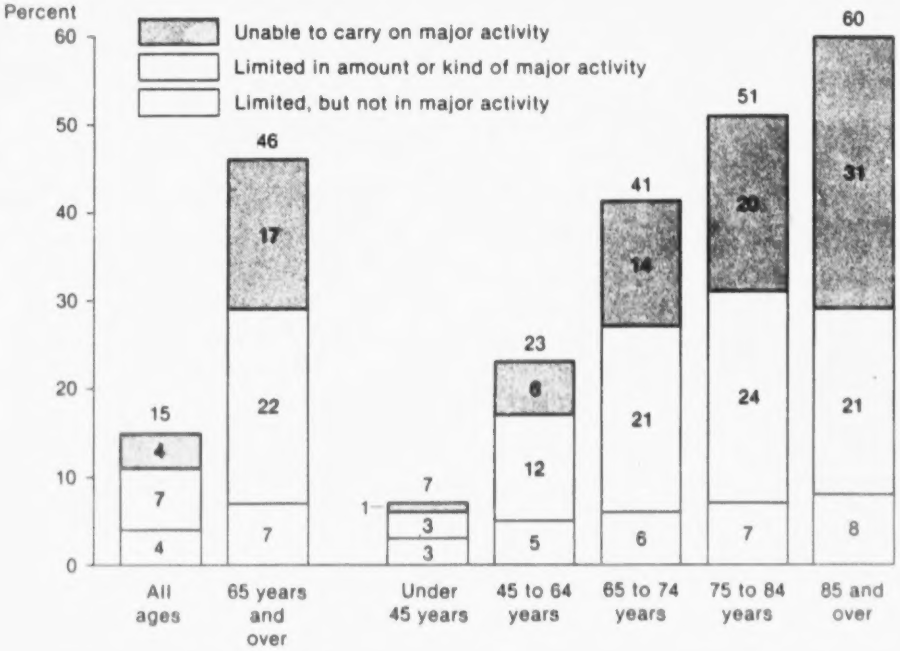
*Projections

Source: *Chartbook on Aging in America* (Washington, D.C.: The 1981 White House Conference on Aging), p. 7.

Figure 3

Percentage of Elderly with Limitation of Activity Due to Chronic Condition

by Age Groups and Type of Limitation: United States, 1978



Note: Includes only those persons with an activity limitation due to a chronic condition. Excludes elderly in institutions.

Source: *The Need for Long*-Term Care: Information and Issues (Washington, D.C.: U.S. Department of Health and Human Services, The Federal Council on the Aging, 1981), p. 29.

3. *Male / female ratios*

Numerical dominance of the population on older Americans by females has always been characteristic of an aging population; the 1980 Census indicates it is more so. Females outnumber males but the differences are even more emphatic at the upper ranges of the age scale. For example, females in the 85 plus group increased by 70 percent between the two Census periods whereas males in the same age group rose only 30.3 percent.

4. *Educational attainment*

Repeated studies have re-affirmed that one's educational attainment is critical—for older people as for others. Elderly of the 1980s are clearly superior in their educational level compared to those of the 1970s, whether it is measured by completion of four years of high shcool, or one or four years of college training. The consequences of the improvement of educational qualifications of elders of the 1980s are revealed in improvements in income, in health condition and in other attributes of significance to specialized transportation developments.

5. *Economic position*

Two distinct trends were discerned in this period. While the absolute numbers of elderly below a pre-determined poverty level fell from 4.1 million to 3.5 million, a hard core of poor elderly remain—perhaps worse off than their 1970 counterparts. At this same time a countervailing finding emerged, which showed that the remainder, about 85 percent, had improved their economic position in 1980.

6. *Employment status*

Older males and females alike, perhaps because of their improved economic position were leaving the labor force, presumably by voluntary decision. Compared to the decade of the 1970s, there is a marked decline in labor force participation by the elderly. It is not yet clear whether this is a temporary or permanent pattern. It is possible that certain changes, such as 1978 passage of The Age Discrimination in Employment Act, which altered national retirement policy from 65 to 70 years, may have a delayed effect and result in different findings in 1990.

7. *Growth of minority elderly*

By reason of differentials in fertility of child bearing females and mortality of the aging among groups, minority elderly are and will be increasing as the decades unfold, particularily elderly who are Spanish—speaking. Despite these signs of changes in the future, as of 1980 white Causacian elderly represented about 90 percent of all older Americans.

8. *Geographic distribution of older Americans*

Population growth of the elderly is unevenly distributed among the states Migration of older persons is a phenomenon which reveals shifts from the North and North Central States to the largely so-called Sunbelt states in the South and West, as shown in Table 4. The proportion of the aging population within each state, by rank order is shown in Table 5.

TABLE 4

Estimated Percentage Increase for Population 65 or Older By States for Period 1970¢1978

State	*Number (000s)*	*Percent of Total Pop. in State, 1978*	*Percent Increase 1970-1978*
A. Increases of 30 Percent or More			
Nevada	55	8.4	79.4
Arizona	269	11.4	66.7
Florida	1510	17.6	53.2
Hawaii	66	7.4	50.8
New Mexico	104	8.5	47.4
Alaska	10	2.5	46.7
South Carolina	258	8.8	35.8
North Carolina	550	9.9	33.6
Utah	102	7.8	32.3
B. Increases from 25 to 30 Percent			
Idaho	87	9.9	29.5
Georgia	473	9.9	29.3
Texas	1264	9.7	28.0
Virginia	468	9.1	27.4
Oregon	285	11.7	26.5
Delaware	55	9.5	26.2
Alabama	408	10.9	25.9
California	2243	10.9	25.1
Tennessee	478	11.0	25.1

SOURCE: Adapted from tables in *Facts about Older Americans* 1976, 1977, 1978, and 1979, U.S. DHEW, Office of Human Development Services, DHEW Pub. No. (OHD) 77-20006, 78-20006, 79-20006 and HHS Pub. No. (80-20006).

To summarize, demographics changes measured by a comparison between the two Census periods of 1970 and 1980, reveal conclusively that the elderly of the 1980s when compared to their counterparts of the 1970s, exhibit the following characteristics: there are more of them; they are older, that is, the categories in the upper ranges of the age spectrum are increasing at a rate that exceeds growth of the older group as a whole; females continue to increase their numbers compared to males, especially in the top rungs of the age ladder; they are better educated; they are in the main stronger economically; their ratio in the labor force is decreasing; minorities within the aging population are growing faster than white Caucasians; and there are sustained migration patterns favoring the so-called Sunbelt states.

It is changes of these kind that need to be taken into account in sorting out the direction of specialized transportation in the U.S. While the full implications of these demographic changes are unfolding gradually, it is possible to suggest the probable directions, for planning and programming purposes.

TABLE 5

U.S. Population 65 and Over by Percent and Number as of 1980

United States	11.3	25,544,133
State	*Percent*	*Number*
Florida	17.3	1,684,972
Arkansas	13.7	312,331
Rhode Island	13.4	126,912
Iowa	13.3	387,498
Missouri	13.2	648,289
South Dakota	13.2	91,014
Nebraska	13.1	205,576
Kansas	13.0	306,179
Pennsylvania	12.9	1,531,107
Massachusetts	12.7	726,531
Maine	12.5	140,918
Oklahoma	12.4	376,042
New York	12.3	2,160,558
North Dakota	12.3	80,447
West Virginia	12.2	237,868
Wisconsin	12.0	564,228
Minnesota	11.8	479,746
New Jersey	11.7	859,682
Connecticut	11.7	364,864
Oregon	11.5	303,284
District of Columbia	11.6	74,202
Mississippi	11.5	289,357
Vermont	11.4	58,166
Tennessee	11.3	517,524
Alabama	11.3	439,938
Arizona	11.3	306,971
Kentucky	11.2	409,853
New Hampshire	11.2	102,967
Illinois	11.0	1,261,160
Ohio	10.8	1,169,437
Indiana	10.7	585,425
Montana	10.7	84,559
Washington	10.4	431,417
North Carolina	10.3	602,273
California	10.2	2,414,755
Delaware	10.0	59,284
Michigan	9.9	912,321
New Mexico	9.9	115,690
Idaho	9.9	93,680
Texas	9.6	1,371,040
Louisiana	9.6	403,939
Georgia	9.5	516,808
Virginia	9.4	505,204
Maryland	9.4	395,594
South Carolina	9.2	287,287
Colorado	8.6	247,261
Navada	8.2	65,767
Hawaii	7.9	76,230
Wyoming	7.9	37,218
Utah	7.5	109,220
Alaska	2.9	11,530

SOURCE: U.S. Department of Commerce, Bureau of the Census, *1980 Census of Population, Supplementary Report* (PC80-S1-1) May 1981.

Transportation Implications of Demographic Changes Among the Elderly

- The demands of the elderly for specialized transportation will increase in the 1980's. This is apparent from the sheer rise in the numbers of older people, in the higher costs of fuel, the increase in costs of purchasing and owning an automobile, and an established and growing demand for mobility among the elderly.
- Most of the riders for specialized transportation services are likely to be female, of advanced age, and drawn from minority groups. The economic position of about one-sixth of the aging population, will identify the core group who are likely to be transportation disadvantaged, in the full sense of that term.
- Specialized transportation programs will need to consider serving an older, probably less physically able population than heretofore. The marked growth of the 85 years and older population will place increasing demands on the specialized transportation network. The network will need to take into account a group of riders who will have some difficulty in ambulating yet be desirous of maintaining a measure of mobility and independence
- Work oriented trips on the part of the elderly will be on the decrease both for specialized transportation programs and mass transportation With diminishing numbers of older persons of both sexes in the labor force a larger proprotion of older people will be seeking trips to more varied destinations beyond employment locations.
- Car ownership will be maintained by a high proportion of older people. Given the alternative life styles of older people of the 1980's, the high costs of owning and operating an automobile and parking in urban areas, older people will make selective use of specialized transportation for some trips. The automobile may be reserved for hard to reach locations and places to which specialized transportation is difficult to obtain or unavailable
- For those unable to drive for physical or economic reasons, their demands in the future are likely to be for a substitute for the automobile; however, conventional public transit may not satisfy their needs as well as personalized dial a-ride or specialized systems.
- Accessibility is likely to be an important issue for the elderly in view of the expected increased limitations on mobility. Given the high proportion of women who have driven previously, the high incidence of frail elderly, the greater emphasis on group living and home delivered services to maintain independence as long as possible, there is likely

to be some preference for personalized specialized service in contrast to lift-equipped accessible conventional transit. An emphasis on "auto-like" transportation will be especially attractive to older women. This may also result in increasing conflict between the elderly disabled and the younger disabled for whom "mainstreaming" is an important issue.

- Though rural elderly have participated in the migration to the Sunbelt states, it has not been at the same level or rate as the urban elderly. One consequence is that the rural elderly who remain behind are often the poorest and most vulnerable members of their communities. It seems quite evident that for the remainder of the decade of the 1980s and into the 1990s, the need for rural transportation is likely to continue but at a higher level. The transit needs of rural elderly will be compounded by lower incomes, lower available public budgets, a more dispersed population, difficulties associated with normal trip making and the lack of a well developed local transportation network comparable to urban areas.

In sum, this assessment of national developments in the U.S. influencing the direction of transportation service addressed to older Americans and handicapped persons suggests two major forces are at play. One is economic, the other is social in origin. The first set of influences consists of financial constraints emanating from the state of the public fisc and the financial temper of the times. The second set of influences is derived from two sources: 1) demographic findings from the 1980 U.S. Census which revealed marked changes in the composition of a heterogenous elderly population; and 2) a consistent demand from the handicapped and their advocates for the provision of transportation services in accord with the principles of equity and normalization.

The paramount issue at the mid-1980s is not whether specialized transportation in the U.S. will survive, clearly it is here to stay, but rather the extent to which the specialized transportation network will muster the resources to structure an appropriately designed and effectively operated modernized transit program to serve the intrinsic and established mobility needs of elderly and handicapped persons.

References

W.G. Bell, "An Overview of Developments in the United States in Transportation for Elderly and Handicapped" in Norman Ashford, William G. Bell and Tom A. Rich (eds) Mobility and Transport for Elderly and Handicapped Persons. Gordon and Breach, New York. 1982.

William G. Bell and Joseph S. Revis, Transportation for Older Americans: Issues and Options for the Decade of the 1980s. U.S. Department of Transportation, Office of Technology and Planning Assistance, Washington, D.C. 1983.

Joseph Revis, "Transportation Problems of the Elderly and the Handicapped An Overview of the United States Experience" in Norman Ashford and William Bell (eds) Mobility for Elderly and Handicapped, Loughborough University of Technology, 1978.

U.S. Administration on Aging, Improving Transportation Services for Older Americans, Vol. 1, General Report. Prepared by the Institute for Public Administration, in association with Ecosometrics, Washington, D.C. September 1980.

U.S. Bureau of the Census. 1980 Census of Population. Characteristics of the Population Part 1 Section 2 U.S. Summary. PC-1-D1. Washington, D.C. Government Printing Office 1983.

U.S. General Accounting Office, Hindrances to Coordinating Transportation of People Participating in Federally Funded Grant Program Vols. I and II, Human Resources Division, General Accounting Office, Washington, D.C. 1977.

William G. Bell, Professor, Department of Urban and Regional Planning, and Research Associate, Institute of Social Science Research, Florida State University, Tallahassee, FL 32306.

Joseph S. Revis is head of J.S. Revis and Associates, Inc., 2804 Battery Place, N.W., Washington, D.C. 20016.

4

Air Transport and the Handicapped Traveller

AIR ACCESSIBILITY STANDARDS: THE CANADIAN MODEL

David Baker

Introduction

A coherent scheme of Air Accessibility Standards is emerging in Canada (hereinafter referred to as the Canadian Model) which may prove to be useful to other countries, both in the development of domestic standards of their own and as the basis for international standards yet to be developed.

The Canadian Model had its origins in a regulatory process committed to protecting "the public interest" and in the non-partisan political atmosphere created by the International Year of the Disabled Person. It has since been buttressed by amendments to the Canadian Human Rights Act and the inclusion of equality protection for the handicapped under the Charter of Rights and Freedoms, both of which are scheduled to come in force April 17, 1985. All of these trends suggest that accessibility will be a right rather than a matter of charity and that the obligation to accommodate the handicapped will be borne by the airlines, as a cost of doing business, rather than by government as a social service.

Origins

In Canada those modes of transportation which are under federal jurisdiction are under the regulatory authority of the Canadian Transport Commission. Each mode is regulated by a modal committee, the decisions of which are appealable to a Review Committee composed of representatives from the other modal committees. In this way it was hoped to create a unified approach to transportation issues, while respecting the diversity of the various modes. The Commission stands at arm's length from government as an independent court of record.[1]

While each modal committee has a somewhat different legislative mandate, distinguishing its jurisdiction from that of Transport Canada (i.e. the federal government's department of transportation), they have in common the responsibility for setting tariffs in what can be broadly defined as the public interest. Naturally, the tariffs established by individual carriers apply, except to the extent the modal committee feels intervention in the public interest is necessary.

In July 1980 the Rail Transport Committee issued its decision in the case of Clariss Kelly, a young law student in a wheelchair who sought to travel from her home to school and back by train. The railway refused to assist her to board its trains and required that she be accompanied at all times by an attendant, who would be charged an additional fare. The Committee considered the competing interests in the case and decided that the public interest lay in favour of granting handicapped people equal access to rail transportation. It found that: "Miss Kelly in our view has much to contribute to society and we (i.e. all other members of society) will lose in the long run by allowing barriers, either financial or otherwise, to be placed in her way when she travels."[2]

In the end the Committee established four major principles, in the form of orders:

1. Disabled people were given the right of self-determination, i.e. the right to decide whether or not they required an attendant.
2. The principle of "one-person one-fare" was adopted, i.e. the attendant was perceived alternatively as an extension of the disabled person or of the services provided by the railway, but in either event would be permitted to travel on the disabled person's ticket.
3. Despite being presented with a plan by the railway to install mechanical lifting devices over time in all major rail stations, the railway was required to immediately provide manual boarding assistance at its 13 largest stations, i.e. equality of access.
4. While aware of the additional risks faced by disabled people when traveling, they were not found to be so substantial as to justify denial of carriage, i.e. the dignity of risk. Also, the railway was not permitted to extract waivers of liability from such passengers. To allow waivers would have reduced the incentive for improved safety procedures reflecting the special needs of disabled passengers.

The Kelly case stands as the Magna Carta of disabled people's rights in Canada, and laid the four corner stones of the Canadian Model: namely, self determination, one-person one-fare, equality of access and dignity of risk.

Removing the "Obstacles"

The four cornerstones were reiterated and expanded upon by the Special Parliamentary Committee on the Disabled and the Handicapped which presented its first major Report in 1981, the International Year of the Disabled Person.[3] Increased public awareness during the

---

[1] H.N. Janisch, The Regulatory Process of the Canadian Transport Commission (LRCC) 1978.

[2] Clariss Kelly v. VIA Rail Canada (1980) 1 CHRR D/97 at 107/8.

[3] Report of the Special Committee on the Disabled and the Handicapped, February 1981 pp. 94-100.

International Year, together with the thoughtful nonpartisan manner in which this all-party Committee conducted its work, contributed to the important impact the Report has had on Canadian consciousness. By the time the Report was issued all transportation modes under federal jurisdiction, save air, had adopted the principles of both self-determination and one-person one-fare. The Report recommended that the same principles should be imposed on airlines.[4] Unfortunately, the complex division of authority between Transport Canada and the Canadian Transport Commission[5] has delayed implementation of these recommendations. The government has made it clear it adopted the Committee's view,[6] however, jurisdiction in the first instance would appear to lie with the Commission

In 1982 the Air Transport Committee of the Commmission decided that the financial burden of requiring a disabled person to pay two fares in addition to supplying an attendant constituted "unjust discrimination" and an "undue or unreasonable prejudice or disadvantage" and imposed the principle of "one-person one-fare".[7] It deferred implementation of the principle until the self-determination issue was resolved by its special advisory Panel on Transportation of the Handicapped.[8] This decision was welcomed by the Special Commmittee, and the Treasury Board approved the funding necessary to permit the Canadian Transport Commission to issue multimodal identification cards to disabled perople who wished to be accompanied by an attendant.[9] In short the pieces seemed to be falling into place. Unfortunately, a procedural irregularity resulted in the overturning of the Air Transport Committee's decision,[10] and while the matter is back before it[11] the delay has been frustrating for the members of the handicapped community.

In the meantime the government moved to implement other recommendations of the Obstacles Report. In November, 1983, a National Policy on Transportation of Disabled Persons was released. Such a policy document is important both for its symbolic value, but also because the Canadian Transport Commission is required to have "due regard" to this when determining what is in the public interest.[12]

The policy defines a disabled person as: "Any person who has a physical, mental or medical condition, either permanent or temporary, that limits his/her ability to use public transportation services. This definition is broad enough to include, among others, the elderly, the obese, pregnant women, and those people with injuries."

The Policy reiterates the principle of self-determination, provides a definition of "extra-ordinary care" distinguishing services which carriers are required to provide from those they are not, and allocates financial responsibility for modifications between the government and carriers. Most importantly it established equitable access to transportation by the removal of all barriers as the Policy's goal. While recognizing cost factors may delay the achievement of this goal, the Policy makes it clear that cost is no excuse for doing nothing or slipping backwards. Those who work in this area will recognize that resources never seem to be available for the accommodations required by the disabled. By spreading the cost over a period of time it becomes possible to make the substantial changes which are necessary. This incremental approach could be described as the fifth and final cornerstone of the Canadian Model.

In August 1984, the former Transport Minister received a report entitled Air Accessibility Standards for Disabled and Elderly Persons from a special advisor. The Report identifies accessibility standards which could reasonably be imposed upon air carriers immediately, along with the legal mechanism for doing so. It also identifies a process through which the standards could be modified and extended over time. While many issues are dealt with in greater particularity than elsewhere, the Report's real contribution lies in identifying a new legal basis for the four cornerstones of the Canadian Model.

When the provisions of the Canadian Human Rights Act and the Canadian Charter of Rights and Freedoms come into full force on April 17, 1985, the adoption of accessibility standards would not significantly alter the legal obligations of carriers. Rather, it would attempt to define them. The basic objective would be to state as specifically as possible, what constitutes "reasonable accommodation" of persons with various disabilities, in as many situations as possible.

---

[4] Ibid recommendation 85 pages 96.

[5] See generally John T. Gray Q.C. then Acting President of the Canadian Transport Commission, "Power and Roles of the Canadian Transport Commission vis-a-vis Those of Transport Canada and the Canadian Human Rights Commission in Matters Relating to Transportation Service to the Handicapped," a speech presented to the Minister's Advisory Committee on Transportation of the Handicapped, July 12, 1983.

[6] Letter from Minister of Transport, Lloyd Axworthy to Angus Morrison, President, Air Transport Association of Canada, December 17, 1983.

[7] Air Transport Committee, Decision No. 6679, March 2, 1982.

[8] Special Parliamentary Committee on the Disabled and the Handicapped, Obstacles: A Progress Report, June 1982 p. 120-1.

[9] Treasury Board Minutes, July 14, 1982 on application from the Economic and Regional Development Committee of Cabinet.

[10] Review Committe of the Canadian Transport Commission Decision No. 1983-02, July 14, 1983.

[11] Air Transport Committee Request for Submission File, No. 13-14, September 23, 1983.

[12] Section 3 National Transportation Act R.S.C 1970 Chap. N-17.

In reality, if such standards are not developed cooperatively and with foresight, they will be imposed ex post facto by human rights tribunals and courts adjudicating specific complaints and civil suits.[13]

On August 21, 1984, the Minister accepted the Report and committed the government to implement is recommendations as soon as possible.

Soon thereafter, there was a general election and a new government assumed office. The incoming government has already made it clear it shares the same goals in this area as its predecessor, but has not yet had an opportunity to review in any detail the Air Accessibility Standards and therefore chooses to reserve comment.[14] That the Canadian Model should survive a change in government is not surprising in light of its non-partisan origins, its consistency with the Charter of Rights and Freedoms and the record of the new Minister of Transport, when in the same portfolio during an earlier administration.

Before leaving the Canadian scene it should also be noted that domestic air carriers appear to have accepted the imposition of the Canadian Model as inevitable and have unilaterially amended their tariffs to allow a degree of self-determination and to provide half fares for attendants as interim steps.

International Implications

It appears unlikely that the efforts of equality-seeking disabled Canadians are likely to be confined by anything so arbitrary as national boundaries, particularly in a transnational industry such as air transportation. Certainly the Canadian government, which is in the process of developing domestic accessibility standards must sooner or later respond to the difficulties its disabled citizens are experiencing when they travel internationally.

At present the only regulation of accessibility to air travel by the disabled is self-regulation by international airlines through their collective representative, the International Air Transport Association (IATA). IATA guidelines are similar to the tariffs of Canadian airlines prior to the emergence of the Canadian Model and regulatory intervention. A carrier is free to refuse to carry a person on the basis of their "incapacity," and is the final judge of what constitutes incapacity. Any person declared to be incapacitated may be required to take a medical examination at their own expense. A person deemed by the carrier as likely to "cause discomfort" or be "objectionable" to other passengers will be considered incapacitated. A ticketed passenger accepted for carriage by a carrier on an outbound flight may be denied passage on the return portion since the authority is exercisable locally. Finally it should be noted that the regulations are advisory only and cannot be enforced.

It is hoped that IATA will voluntarily choose to amend its regulations, but in the event it does not there may be certain private remedies which are applicable. For example, there are tort cases in the United States which suggest common law remedies may be sought for the actions of the carrier's agents in another country. Thus in circumstances where a person is assured he may travel unattended by an airline, and is subsequently refused carriage on the return portion of his ticket, civil remedies are available.[15] Similarly the Canadian Human Rights Commission and the Canadian Transport Commission have jurisdiction to receive private complaints against any air carrier operating in Canadian air space, whether or not the flight is international.[16]

Because of the international character of air travel, much regulation is carried on through treaties between governments. At present Canada is a party to twenty such multi-lateral agreements and amendments, most notably the Warsaw Convention and the Chicago Convention as well as thirty-one bi-lateral agreements with individual countries.[17]

Most of the bi-lateral agreements contain a clause to the effect:

> the laws, regulations and procedures of one contracting party relating to admission to or departure from its territory of aircraft engaged in international air navigation or the operation and navigation of such aircraft shall be complied with . . . upon entrance into, departure from and within the said territory.[18]

Thus in theory an airline operating in Canadian airspace must abide by Canadian law governing air accessibility for the disabled; however, in practice the Canadian Model is intended for domestic air travel and would not be extended unilaterally by the Canadian government. Nonetheless it would appear that the Charter of Rights, extending as it does the rights of the individual vis-a-vis the state, and governing such prerogative powers as the Crown's authority over external affairs,[19] may afford a disabled litigant authority to invalidate covenants which inadequately safeguard the equality rights of disabled travelers.

---

[13] Ed Ratushny, Air Accessibility Standards for Disabled and Elderly Persons Transport Canada, August 1984, p. xviii.

[14] Conversation with Ms. Melody Tomka, Executive Assistant to Transport Minister Don Mazankowski, responsible for issues concerning the disabled, August 24, 1984.

[15] Angel v. Pan American World Airways Inc. 519 F. Supp. 1173 (1981).

[16] Aeronautics Act R.S.C. 1970 Chap. A.-3 section 9(1) "commercial air service" means any use of air craft in or over Canada for hire or reward.

[17] C. Wiktor (ed.) Canadian Treaty Calendar (1982).

[18] Air Agreement between the Government of Canada and the Government of the French Republic (1977) Article 5.

[19] Peter Hogg "A Comparison of the Canadian Charter of Rights and Freedoms with the Canadian Bill of Rights" in Tarnopolsky and Beaudoin (ed.) Canadian Charter of Rights and Freedoms (1982) p. 7.

If this creates an image of Canada as a country bristling with handicapped people eager to launch law suits against any air carrier which strays into its airspace, this was not the intention. The Canadian tradition has always been to avoid litigation and to resolve matters through discussion wherever possible. It is significant to point out, however, that the Canadian government may in the future be more concerned than it has been in the past to show leadership in developing air accessibility standards for inclusion in its bilateral agreements.

There are also international developments centered on the United Nations in New York which bear watching.

Canada became a member of the United Nations in 1945. In doing so, Canada pledged itself to follow article 55(1) of the U.S. Charter whereby, ". . . the U.N. shall promote: universal respect for the observance of human rights and fundamental freedoms for all . . ." The foundation document for the international protection of human rights is the Universal Declaration of Human Rights (1948). While the disabled are not specifically listed as a protected class under article 2 which states "Everyone is entitled to all rights and freedoms set forth in this Declaration without discrimination of any kind, such as race, colour . . . birth or other status". The International Commission on Human Rights has interpreted the open ended category of "other status" as including the disabled. The subsequent passage of the Declaration on the Rights of Mentally Retarded Persons (1971)[20], the Declaration on the Rights of Disabled Persons (1975)[21] and the election of a U.S. Sub-Committee on the Protection of Minorities specifically to consider the interests of handicapped persons further substantiates this position.

Article 6 in the Universal Declaration establishes everyone ". . . has the recoginition everywhere as a person". In article 7 ". . . (all) are entitled to equal protection against any discrimination". Article 13 guarantees everyone ". . . the right to freedom of movement . . . within the borders of each state . . ." and the ". . . right to leave any country . . . and return to his own country . . ." Finally, article 22 establishes ". . . the right to social security . . ." and entitles everyone to ". . . realization . . . of economic, social and cultural rights indispensible for his dignity".

In addition, the U.N. has designated 1983-1992 as the Decade for Disabled Persons and launched a World Program of Action (WPA) concerning Disabled Persons the objectives of which are "to promote effective measures for prevention of disability, rehabilitation and the realization of full participation goals in social life, development and equality".[22]

Perhaps more importantly, the World Council of Disabled Persons International was granted Consultative Status with the Economic and Social Council of the United Nations on February 10, 1983. This means the handicapped community for the first time has an effective international voice at the U.N. and a base from which to push for amendments to the Warsaw Convention through the International Civil Aviation Organization (ICAO) and the Economic and Cultural Council of the U.N. or to facilitate cases before the U.N. Commission on Human Rights.

Conclusion

It is felt that the domestic and international implications of the Canadian Model have a common basis in the clear trend towards enforcement of human rights for disabled people. Certainly the human rights principles of equality of access and removal of barriers through reasonable accommodation hold out great hope for a group which has been excluded from the mainstream for too long.

In Canada, the simple demographics of an aging population suggest that to delay further will only lead to greater social and economic costs for air carriers and the public as a whole.

What is required is the combined commitment of the air carriers, the manufacturers and government to remove the barriers in a concerted and purposeful manner. The Canadian Model is presented as evidence of what can be accomplished immediately and that long term goals can be set which are both achievable and effective in granting handicapped people the right to fly.

David Baker, an attorney, is Executive Director, Advocacy Resource Center for the Handicapped (ARCH), 40 Orchard View Blvd., Toronto, Ontario, Canada M4R 1B9. Mr. Baker represented Clariss Kelly in Kelly vs VIA Rail Canada (1980).

---

[20] U.N. Doc. A/8429 (1971).

[21] U.N. Doc. A/XXX/3447 (1975).

[22] U.N. General Assembly Resolution December, 1982.

COPING WITH THE HANDICAPPED AIR TRAVELLER

J. Dunlop

Introduction

In examining this problem, one may start by looking at the problems associated with air travel for the elderly and disabled, and describing some of the solutions being instituted at present and the outlook for the immediate future. Consideration will be given mainly to the mobility impaired passengers, mobility impaired either by accident, disease or age. The first problem is to get to the airport. On arrival the next problem is an obvious one, crowds of people on the pavement, in the terminal, or if the arrival is by air, at immigration. Then there is the inevitable change of level to raise the passengers to the height of the aircraft door, and long corridors to get out to the aircraft stands. Such corridors often have moving travelators to carry people but moving belts can be a hazard to anyone with an unsteady gait particularly at the exit point. All this must be overcome before even approaching an aircraft. However the duties of an airline to its passengers begin at check-in; therefore ground problems should be included. The aircraft itself has narrow doors and narrow aisles between seats. An aircraft aisle is a minimum width of fifteen inches wide at seat level and twenty two inches minimum width at the level of the seat back.

Some of the solutions to this "hurdle race" facing the air passengers with a mobility problem can now be examined. First of all a plea must be made for prior notification. Though this is not always necessary it makes the job of the airline easier if it is asked in advance for any special facility required, be it a vegetarian meal or a wheelchair. With advance notice almost anything is possible. Those with a problem with mobility should request wheelchair assistance. A porter can bring a wheelchair to the kerbside and he will then render assistance, if necessary, through the airport formalities of check-in, immigration and via the lift to the transit lounge where bar, coffee shop, bookshop and toilets will be available. It is obvious that male porters do not normally wheel female passengers into the ladies' toilet, but toilets of course should be unisexed since there is usually a spouse who accompanies the passenger. Passengers with their own wheelchair have no need for a porter. Special desks are being installed at airports for use of wheelchair users. For passengers who do not require a wheelchair but have difficulty with the long distances there is an electric buggy available. If the aircraft is not attached to a jetty but has stairs a specially built vehicle is available with a tailgate lift for use of wheelchair users. This vehicle can be positioned to meet the aircraft door, whatever the type of aircraft, large or small.

And so to the interior of the aircraft and the next hurdle, the narrow aisle. Here it is necessary to transfer to a narrow wheelchair. The old type of on board wheelchair formerly in use has now been replaced; mention will be made of this replacement later. The next problem is the aircraft seat. With most old seats the disabled passenger has to be lifted high over the fixed aisle side arm rest of the seat. Now aircrft are being fitted with seats with lift-up aisle side arm rests and the passenger can transfer with or without assistance but without the hazards of the armrest. Once on board the passenger can expect a nice flight. But is that so? What about using the aircraft toilet? If it is a short flight this will probably not be necessary, but it it is a long flight the passenger with a severe mobility problem, either has to dehydrate for hours before and during the flight in order to obviate the need for the toilet or has to be fitted with some urinary device.

This problem has been examined by British Airways for the last three years and various solutions have been offered. An earlier example of a chair designed by Peter Kawalowski of Lockheed Aircraft provides a seat which transfers backwards over the toilet. The whole chair can fold up to be stored under an aircraft seat when not in use. Unfortunately it did not prove satisfactorily in use in "anger." Recently Airbus Industries and M.B.B. in Germany have introduced an improved seat with a similar principle. A number of airlines including British Airways have gone for a simple solution. All their wide-bodied aircraft are being fitted with a simple on-board narrow wheelchair, without large wheels but with wheel rims. The same chair, with wheel rims, is also used now on the ground in the airport and is proving very popular since it gives the passenger mobility in the airport lounge. When the times comes to board the aircraft the large wheels are removed leaving the chair sixteen inches wide. The passenger can then be pushed down the aircrft aisle to the seat. The chair folds flat for storage in the plane when it is not needed. During the flight the passenger can request the crew to bring the chair and thus transfer to the aircraft toilet In the toilet the back of the chair can be removed to enable a direct rearward transfer from the chair on to the toilet. Alternatively the arm of the wheelchair can be removed to enable a 90° transfer which most people seem to prefer. It is proposed to install a complete system on board the aircraft comprising lift-up aisle side armrests, on board wheelchair and a specially adapted toilet with armrests. strategically fitted, to assist the disabled passenger with a mobility problem to travel in comfort.

It is worth returning for a moment to prior notification i.e. letting the airline know of needs before travelling. Many disabled people object to this and one can sympathize with this in principle, but it is clear that the degree of mobility or immobility of a passenger would determine the equipment required and the number of staff involved in loading the passenger. With prior notification this can be arranged beforehand and disappointment can be avoided. However there is another reason. There is an increased misuse of wheelchairs. An article in a business travel magazine recommended its able-bodies readers to request a wheelchair if they wanted a guaranteed seat in the lounge, assistance through airport formalities, assistance with baggage and pre-boarding. Airlines aim to protect wheelchairs for those with a genuine need for them.

Turning to the immediate future, what has been described is what is planned; it must be admitted that these provisions are not yet adopted universally. Various airlines have installed various parts of the whole. Most are training cabin crews in lifting and handling techniques and many are using an excellent film produced by T.W.A. called "They See My Chrome." This can be recommended to anyone involved in training of staff. A number of airlines have installed lift-up armrests on some seats but the positioning of the seats so adapted, depends on giving a choice of seating to the passenger, of smoking, non-smoking, class of travel, access to the toilet, etc. A few airlines have an on board wheelchair. Many more are intending to start using such a chair. A few have already adapted some toilets on their aircraft; most airlines are working towards this direction. Thus the situation at present is very patchy, and it will be at least another year before such facilities are common. It is a very lengthy and expensive exercise to carry out any change on board an aircrft. For example, the tooling cost alone for British Airways for the parts for the lift-up armrests are approximate U.S. $100,000 and the cost of only the fuel to carry the extra weight of the on board wheelchair, weighing 28 lbs, is 60,000 pounds sterling per annum. This has meant some research into numbers of passengers requiring such facilities, and the number of potential passengers, an area which will be dealt with later in this paper.

What of disabled or impaired passengers with needs other than wheelchairs? Approximately one percent of the population have some degree of visual impairment. Many airlines are introducing emergency cards in Braille, but only ten percent of blind people can read Braille and it is not an international language. Cabin crew training is very important for the visually handicapped, as are clear announcements, but at least one airport has stopped all public address announcements since it felt that there were so many no one was listening. Announcements had become part of the general background noise. Those passengers with a hearing impairment are much better served with visual display units throughout the airports, and large signboards showing departures and arrivals. On board the aircraft now there is a system for displaying information on the bulkhead and safety demonstrations can be given in the in-flight entertainment screens with sub-titles. There is an increase in use of inductive loop systems inside airport buildings but these cannot be used inside the airplane itself. Indeed it is generally held that hearing aids are of little use on board aircraft due to the high noise level.

Another major problem is the dissemination of information, i.e., telling people what airlines are doing and what facilities are available. A conference such as this is ideal for this purpose. There are a large number of publications, of course, but it is very difficult to keep these up to date. Examples of available material are the Department of Transportation booklet, the three International Air Travel Association (I.A.T.A.) booklets, the British Airport Authority booklets, airline publications and, of course, Ninnescah Services. Sometimes even airline staff do not know what is available for the incapacitated passenger. Another most important link in the information chain is the travel agent, who does most of the bookings and travel arrangements; this is one area being particularly addressed in the United Kingdom.

A Study of Incapactated Passengers Requesting Special Facilities

Anyone requesting special facilities on a flight is asked to complete a MEDIF form. Part One of this daunting form is now called INCAD (Incapacitated Passengers Advice). During 1980, British Airways received 28,500 of these forms of which a sample of 1,000 were analyzed and the results are reported here.

In the body of this report a number of terms need definition:

> *FREMEC card*—(formerly in British Airways a "Regular Travellers Medical Card"), is issued to travellers with a chronic disability. It means no medical clearance is required i.e. they are FRee from MEdical Clearance. British Airways have issued approximately 240 of either the new FREMEC card or its predecessor. Questionnaires were sent to all holders of these cards (Annex 1).
>
> Wheelchair passengers are classified into three categories by code, 1) SCHR: requiring wheelchair facilities to the bottom of the aircraft steps , 2) WCHS: requiring help also up the steps to the door of the aircraft, 3) WCHC: requiring assistance all the way to the aircraft seat.

ANNEX 1
QUESTIONNAIRE TO FREMEC CARD HOLDERS

BRITISH AIRWAYS would like to improve its service to its incapacitated passengers and consequently is asking those passengers to assist it in making suggestions for improvements. We would be most grateful if you would complete the following questions as fully as possible. we need as much information as we can get in order to have the fullest understanding of your needs.

1. How many times have you travelled by air in the past two years?

   ☐ Once ☐ Two-five times ☐ More than five times

2. What is your usual reason for travelling by air?

   ☐ Vacation ☐ Business ☐ To visit relatives ☐ Other (describe)

3. How many relatives or friends normally travel with you?

4. List the biggest problems, in order of importance, that you meet in travelling by air.

   a.

   b.

   c.

   d.

5. Have you flown on other airlines? ☐ Yes ☐ No

6. (if yes) Did you find significant differences in service to you? ☐ Yes ☐ No

7. (if yes) Were these differences enough to cause you to choose one airline over another if you could?

   ☐ Yes ☐ No

8. Do you have friends who are disabled who do not travel by air, and would travel by air if the problems you list in ≠ 4 above were improved?

   ☐ Yes ☐ No

9. (if yes) How many can you think of?

PERSONAL INFORMATION

In order to correlate the information you give us with that given by other incapacitated passengers, we need the following information:

Age ____________ Sex ____________ Married? ____________ Occupation ____________

Please briefly describe your incapacity:

It is necessary with such questionnaires as this to make them general enough to fit everyone. However, we know that some of our incapacitated passengers will have a great deal of additional information to give us. Please give us any additional information that you think is important.

THANK YOU VERY MUCH FOR YOUR HELP!

British Airways has a route network which can be regarded as composed of three sub-networks: internal to the United Kingdom, short hand to Europe (less than four hours and London-Worldwide (long hand flights usually over four hours). Through Heathrow, British Airways' main base, these flights currently operate through three terminals:

> Terminal One is mainly internal British flights and London to Europe.
>
> Terminal Two is used by other airlines with mixed destinations.
>
> Terminal Three is mainly intercontinental flights.

Table 1 shows the mix of incapacitated passengers travelling British Airways going through each terminal in 1978.

TABLE 1

Breakdown of Incapacitated Passengers by Terminal

Heathrow Terminal Study 1978

Terminal	*Total Incapacitated Passengers*	*Total Passengers*	*Percent*
T.1.	30.325	9.195.500	0.32
T.2.	7.720	2.863.000	0.26
T.3.	26.395	3.096.000	0.85
	64.450	**15.154.500**	**0.43**

Terminal	*WCHR*	*Percent*	*WCHS*	*Percent*	*Stretcher & WCHC*	*Percent*
T.1.	24.730	52	5.450	39	145	4.9
T.2.	6.360	13.3	1.285	9.2	85	2.9
T.3.	16.500	34.7	7.220	51.8	2675	92.2
Percentage		**73.8**		**21.7**		**4.5**

Table 2 indicates the destinations of sampled 1000 incapacitated passenger records. The analysis was carried out only for WCHC and WCHS passengers. The records for WCHR passengers, who mainly ask for assistance as late as the check in desk, were unreliable.

Analysis was then made of the requests for special seating and in particular those passengers requesting a seat near the toilet. In other words they have very limited mobility inside the aircraft. This was relevant since one of the main objects of the Access to the Skies programme is to enable people more easily to get to the toilet and it would be useful to have some idea of people who have actually requested special seating.

Table 3 shows the results and the reasons for asking for such special seating.

TABLE 2

Destinations of Handicapped Passengers

Heathrow Terminal Study 1978

1. *WCHC Passengers*. Total 139, i.e. approximately 14% of all incapacitated passengers. (But note that such passengers are more likely to pre-notify since they require most assistance).

Europe	100	Approximately 25 were U.K. Internal
U.S.A. & Canada & Caribbean	12	
Middle East	9	Mainly people with a medical condition.
Africa	8	
Australia	7	
Far East	3	

i.e. less than 4 hours—71%
more than 4 hours—28% of WCHC and 3.9 of total incapacitated passengers.

2. *WCHS*. Passengers Mobile inside aircraft.

Europe	87	
Australia	47	elderly visiting friends and relations
Africa	32	some elderly
U.S.A. & Canada	20	
Middle East	15	again mainly medical
Far East	8	
	209	

TABLE 3

Request for Seating Near Toilet

Elderly—arthritis etc.	31
Hemiplegia—mainly elderly	23
M.S.	10
Chronic heart condition	9
Bladder problem	8
Cancer—various	8
Fractures	7
Chronic back trouble	6
Muscular Dystrophy	5
Rheumatoid arthritis	4
Artificial leg	4
Spastic	4
Old Polio	3
Recent operation—hip and appendix	2
Psyche problem	2
DVT	2
Cirrhosis	1
Myasthenia Gravis	1
Freid Ataxia	1
Parkinsons	1
	131

Tables 4, 5 and 6 indicate the diagnosis given on the MEDIF forms, for the various level of indicated disability.

TABLE 4

WCHR Travellers

Chronic heart condition	45
Elderly and arthritis	39
Recent operation	29
Old stroke—hemiplegia	22
Cancer	20
Injury	15
Elderly	15
Chronic back trouble	10
No diagnosis	9
Arteriosclerosis	9
Chronic lung trouble	9
Blood condition e.g. anemia, leukemia	7
Multiple sclerosis	7
Rheumatoid arthritis	4
Parkinsons	3
Abdominal condition e.g. ulcer	2
Elderly and blind	1
Myasthenia Gravis	1
Spastic	1
Old polio	1
Artificial leg	1
Mentally disturbed	1
	252

TABLE 5

WCHS Travellers

Elderly and arthritic	37
Fractures (Europe-skiing)	32
Old stroke	24
Elderly and chronic heart condition	16
Chronic back trouble	11
Elderly	11
Multiple sclerosis	9
Cancer	8
Recent operation	8
Old polio	7
Chronic lung condition	7
Spastic	6
Abdominal condition, including artifical kidney (increased weight allowance)	4
Parkinsons disease	4
Elderly with some mental disturbance	4
Chronic blood condition	3
Arteriosclerosis	3
Muscular dystrophy	2
Paraplegic	2
Elderly and blind	2
Osteoporis	2
Rheumatoid arthritis	1
Elderly with mental condition	1
Ataxia	1
	205

TABLE 6

WCHC Passengers

Paraplegia	29
Multiple sclerosis	17
Elderly with arthritis	17
Cerebral palsy	16
Fractures	16
Old Stroke	12
Muscular Dystrophy Cancer	6
Rheumatoid arthritis	3
Renal Disease	3
Spina Bifida	2
Elderly with chronic heart condition	2
Old polio	2
Arthritical leg	2
Osteogenesis imperfecta	1
Syringomyelia	1
Ataxia	1
Quadraplegia	1
	138

Analysis of the replies to the questionnaire sent to the FREMEC card holders (Annex 1), is more difficult since they were given the opportunity to reply in free format to some questions. Replies to Questions 1 and 2 are shown in Table 7.

TABLE 7

Frequency of Travel

Times travelled by air	*Number of Passengers*	*Reason for Travel*
0	2	
1	11	All V & R
2-5	79	
more than 5	84	Mainly business
	176	

Results were as expected i.e., frequent travellers travelled mainly for business, some to visit hospital inside the U.K. and some to go to school. Replies to Question 3 totaled 165 accompanied passengers at best i.e. approximately 1 per disabled passenger. This varied from many who replied nil to one person who replied nine or ten accompanying passengers going to paraplegic games. Approximately half replied "two accompanying passengers."

Replies to Questions 5, 6 and 7 are shown in Table 8.

Replies to questions 8 and 9 are shown in Table 9.

TABLE 8

Comparable Service Levels

	Number	*Percent*
No to Q5	28	17%
Yes to Q5 No to Q 6	77	47%
Yes to Q5 Yes to Q6 Yes to Q7	46	28%
(This question was ambiguous—does not specify which airline preferred:)		
Yes to Q 5 Yes to Q6 No to Q7	12	7%

TABLE 9

Effect of Improving Service

Question 8

Yes—29 16%

Question 9

How many?—21 people answered with a number of 2-8. 4 answered "many"

TABLE 10

Problems—Sound Facilities

1.	Lack of help in foreign countries	8
2.	Lack of parking facilities for disabled at airports	8
3.	Lack of information re air travel for disabled	6
4.	Distance from check in to aircraft	6
5.	Shortage of porters at airports	3
6.	Journey from London to London Heathrow	2
7.	Making original arrangements with travel agent	2
8.	Getting a taxi at Gatwick Airport	1
9.	Non availability of unisex disabled toilets in U.S.A., O'Hare, Chicago and New Orleans; U.K. OK:	1

TABLE 11

Problems—Airline

1.	Difficulty in using aircraft toilet	42
2.	Poor leg room	28
3.	Having to use airport wheelchairs	23
4.	Inability to climb stairs	21
5.	Getting to and from aircraft	20
6.	Lack of information by check in staff	20
7.	Availability of lifting equipment	17
8.	Attitude of airport staff	14
9.	Long waits at airports	14
10.	Not being able to pre-book seats	12
11.	Narrow aisles on aircraft	7
12.	Delay in off loading	6
13.	Shortage of airport wheelchairs	5
14.	Collecting bags from conveyor	4
15.	Getting suitable diet on board aircraft e.g. diabetic	4
16.	Fixed aisle side seat arm	4
17.	Communication problem e.g. deaf	4
18.	Wait at check-in	4
19.	Not being pre-boarded	4
20.	Walking onboard aircraft	3
21.	Too hot inside aircraft	3
22.	Not being able to get bulkhead seat	3
23.	Having to pay normal fare for escort	2
24.	Aircraft meals	1
25.	Poor design of airport wheelchairs	1
26.	Aircraft seats too narrow	1
27.	Other passengers have too much cabin baggage	1
28.	Being pre-booked	1
29.	Transport for wheelchair to aircraft seat	1
30.	Design of carry chairs	1
31.	Poor shape of aircraft seats	1

The replies to the remaining Question 4 which were many and varied. An attempt was made to split the problems as stated into problems with ground facilities and problems that were the responsibility of the airline. The replies are detailed in Tables 10 and 11. It should be noted that the number of problems bears no relation to the number of replies to the questionnaire, since each person was allowed to name as many problems as were felt to exist.

Two hundred thirty questionnaires in all were sent out. Some 176 replies were received, or 76.5 percent, which is a very high percentage for any mail questionnaire. Three were sent back stating that the passenger had left that address and six card holders, unfortunately had died. Seven card holders requested renewal of their cards, or a change of address. All these results have been included in the response rate. A total of 185 replies in all were received, which is an overall percentage reply rate of 80 percent, giving an indication of the amount of interest in this subject within this particular population.

Follow up Study

A follow up study was carried out of all forms for the year 1981. There were a total of 17,263 such forms. During this period the total number of passengers carried worldwide by British Airways was 15.2M so this total number requesting assistance equals 0.11 percent i.e., one passenger in every thousand.

The number of FREMEC cards issued at that time was approximately 250. As of August 1984 there are approximately 500 FREMEC cards issued by British Airways. The majority of such cardholders are wheelchairs users.

TABLE 12

Diagnoses of Reasons for Requesting Disabled Assistance (1981 data)

	WCHR	*WCHS*	*WCHC*
Orthopaedic—arthritis, elderly	1829	1799	636
C.V.S.—stroke, blood disorders	1121	776	288
Respiratory	251	186	34
Abdominal	289	107	20
Urogenital	59	33	9
E.N.T. & Eyes	68	29	11
Psychiatric	10	6	3
C.N.S.—M.S., Epilepsy, Downs, Polio, Paraplegic	350	649	1721
Obstetrics & Gynecological	21	7	0
Metabolic	48	29	4

The reservations system automatically highlights requests for wheelchairs to FREMEC cardholders requesting special facilities can be noted. During the period in question there were 94 users of the card, i.e. approximately 37 percent were used in the year. This result is difficult to interpret, however, approximate half of the users used their cards more than five times in a year.

An analysis of all MEDIF forms returned showed that the statistics in the early work were more or less valid. There were 2,724 requests for WCHC i.e. 16 percent of the total. Of all the WCHC, 65 percent were for short-haul journeys i.e. of less than four hours duratin and 35 percent were long haul journeys, greater than four hours in duration.

There were 3,628 requests for WCHS i.e. 21 percent of the total forms and of these requests 43 percent were for shorthaul journeys and 57 percent for long haul.

The reason given for requesting special facilities were grouped into standard medical categories. The results are shown in Table 12.

J. Dunlop M.D., Senior Overseas Medical Officer, British Airways, Aeroaio House, Southall, Middlesex, England. UB2 5NJ.

PROVISION FOR THE DISABLED: AN AIRCRAFT MANUFACTURER'S PERSPECTIVE

Werner Gronow

Introduction and Backgound

In 1978, the Federal Aviation Administration requested that the Aerospace Association of American investigate the feasibility of developing for new aircraft, and perhaps for retrofitted aircraft, movable armrests on aisle seats to facilitate passenger transfer from a wheelchair to a seat in the aircraft. This request was assigned to the Transport Airworthiness Requirements Committee of AIA (TARC) which shortly thereafter established TARC Project Group 218-2 to investigate this request and make recommendations to the AIA-TARC Committee. Representatives of the three major United States aircraft companies, Boeing, Lockheed and McDonnell Douglas were members of the project group. Airbus Industries, although not a formal member of the TARC 218-2, participated in the program to ensure a worldwide standard would be considered.

With concurrence of the AIA, the TARC Projects Group 218-2 in 1979 expanded the scope of the program to include other aspects for carriage of handicapped persons. The committee scope was limited, however, to accommodation considerations aboard the aircraft, since the terminal and ground handling problems fall most logically in the domain of the airline and airport authority operations, and are not in the purview of airframe manufacturers.

The committee began in 1979, working in conjunction with many of the groups and agencies represented at this meeting, to select those areas of cabin accommodation thought to represent major obstacles to travel by the disabled. The committee continued its investigation and evaluation of proposed solutions to problems of the disabled traveler through 1980. In June, 1981, concluded the program with submittal of the Project Report, "Carriage of Handicapped Persons," to the AIA TARC Committee.

This report recommends passenger seat movable armrests, airborne wheelchair, lavatory accessibility, assist handles inside the lavatories, curtain/door vanity close-offs adjacent to lavatories, as well as other items of benefit to the wheelchair dependent passenger. The report provided suggested solutions to these problem areas, and was offered as a design guide for the future.

The foregoing description of TARC activity is only to establish a frame of reference on current status and to acquaint those new to this area with some of the considerable effort which has already been accomplished.

The TARC 218-2 Project Group went dormant with release of its final report.

Activities of Airbus Industries

Moving to the activities of Airbus Industries (AI) in this field, there has been work on a number of problem areas:

1. Passenger seats

Although as airframe manufacturer Airbus Industries does not produce the passenger seats, it does install them. In such a case, the airframe manufacturer can have only an advisory role. The interest of the aircraft seat manufacturers is a good example of how the total industry cooperated on the problem. Almost all were quick to respond with new adaptations of what were really old designs for movable aisle armrests. Consequently, since the introduction of the A310 almost all Airbus Industries (AL) aircraft were delivered with a certain number of such special seats. Airbus Industries, itself, concentrated on creating or improving new designs on those relevant interior components which are manufactured by the consortium.

2. Lavatory Design

A major effort for Airbus Industries, and its consortium partner in Germany, Messerschmitt, Bolkow, Blohm (MBB), was to improve the designs of the lavatories of both the A300 and A310 aircraft. Both types are wide-bodied, and capable of flying the long distances which demand more lavatory accessibility for disabled passengers. Such designs which have been developed have been in accordance with the recommendations of the TARC 218-2 Committee, as well as additional research on the needs of wheelchair users in flight for mobility. After a thorough study of the many different interior versions of the A300 and A310, it was determined that the two rear lavatories on both aircraft are the most suitable for adaptation for use with disabled passengers. Both lavatories provide sufficient space for both the passenger and an attendant if need be. Privacy can be assured without the use of a curtain. Because of the larger size, these lavatories also are equipped with nursing tables for mothers traveling with infants.

Attention was given to a number of different items in the lavatory. One was the installation of handles and handrails in accordance with the best ergonomic standards, and compatible with the structure of the aircraft interior and space availability within the lavatory.

The location and dimensions of the handles and handrails are such as not to hamper movement of either disabled nor non-disabled passengers, and also not to interfere with the nursing tables.

Vertical bumper strips have been installed to protect the lower edge of the lavatory door, as well as threshold ramps to facilitate wheelchair entry and exit. In addition to the TARC requirements and as extra care for the handicapped passengers, the interior appointments of the lavatory have been redesigned to allow easier use by passengers in wheelchairs. They include an inclination of the mirror so that it can be better used by someone in a wheelchair, a large-surface flight attendant call button which can be pushed by the flat of the hand, and a large-surface flush button for the toilet which can also be pushed by the flat of the hand.

These design improvements have been available since the spring of 1983, and the majority of A300 and A310 aircraft since have had these designs installed by Airbus Industries at the request of purchasing air carriers.

As can be seen this program of lavatory improvements has been aided by the fortunate basic design of both the A300 and the A310.

3. Development of an On-Board Wheelchair (OBW)

The other major area of research and design of Airbus Industries was the development of an on-board wheelchair which offers as complete a service to the disabled passenger as it is possible with the present state of engineering art.

A significant feature is the ability of the wheelchair to place a disabled passenger over the toilet while remaining in the chair. Thus the need for the passenger to transfer from the chair is eliminated. The design of the wheelchair is the result of extensive research by MBB, the German consortium partner, and with expert consultation by Dr. Paul Dollfus, former ICTA Commission President, and Medical Director of the Rehabilitation Center in Mulhouse. The chair, in its present design, traverses aircraft aisles and clears all obstructions, allowing the passenger to move from the seat to the lavatory. A key feature is its capacity to be positioned and locked over the toilet.

Major attention has been given not only to space and aesthetic considerations, but also to the complex of hygiene and sanitation for users, attendants and fellow passengers, which have been addressed satisfactorily.

Airbus Industries recognizes that the use of this particular on-board wheelchair is not the only option to bringing a wheelchair bound passenger to the lavatory. But it is believed to be the most convenient solution, as it avoids two other transfers and offers often neglected comfort when undoing the clothes. With the AI on-board chair the passenger remains on a clean personal chair and benefits from the ability of partially reclining to facilitate dressing or undressing. The handicapped person does not therefore have to carry out these manoeuvres on a sometimes unhygienic toilet seat. It is this extra care and comfort which AI wanted to be able to offer to the less favoured. The chair, weighs only 16 kg (35 lbs) and folds into a neat, under-seat package when not in use. Although designed for A330/A310 aircraft, it can be adapted for use on most other wide-bodied aircraft.

A prototype of the on-board wheelchair was shown publicly at the 15th World Congress of Rehabilitation International in Lisbon, Portugal, in June, 1984, and received many favorable comments. Meanwhile, a series of tests with about 20 handicapped persons has been accomplished at the Rehabilitation Center in Mulhouse. These realistic tests covered all functions of the on-board wheelchair including the hygienic and ergonomic aspects. Some ten detailed improvements resulted from the testing and are incorporated in the seat model presented at this conference.

Werner Gronow is Department Manager, Cabin Interiors, Airbus Industries, Toulouse, France.

80

AIRPORTS AND THE HANDICAPPED TRAVELLER— A BRITISH PERSPECTIVE

Alistair Matson

Introduction

Probably for most air travellers, the period in the airport terminal is the most tiresome phase of the journey. Queues, crowds, noise, bustle—and generally, considerable anxiety and apprehension—are all part of the airport scene, certainly at the big international airports. This can be a daunting prospect for any but the more experienced traveller and for those with mobility problems or sensory impairments it may even be a factor to deter them from air travel.

In recent years and particularly since the International Year of Disabled People (IYDP), 1981, air travel has become more available to people with disabilities. Aircraft manufacturers are tackling mobility problems in the cabin and airlines have agreed common procedures for medical clearance and the provision of assistance during the journey.

As airport operators, the British Airports Authority (BAA) has recognized for many years that some travellers may find it difficult to cope at the airport by designing its passenger buildings to allow for the free flow of passengers particularly those in wheelchairs or those who find it difficult to walk the distances involved between concourse and aircraft. Appropriate building design with supporting services has been the key aspect of BAA's policy towards elderly and handicapped passengers.

This paper describes the evolution of this policy in the context of BAA's role in the operation of its airports and how the policy is implemented.

The Role of the British Airports Authority

The BAA is the major U.K. airport operator. It was set up in 1965 by Act of Parliament to run, on a commercial basis, London's Heathrow, Gatwick and Stansted Airports and Prestwick Airport in Scotland, later acquiring Edinburgh, Glasgow and Aberdeen Airports. Heathrow is the world-leader in the number of international passengers handled 22.3 million in 1983/4 while Gatwick ranks fourth with 11.5 milion (BAA, 1984).

The primary objective of the Authority is "to respond to the present and future needs of air transport by operating, planning and developing its airports so that air travellers . . . may pass though safely, swiftly and as conveniently as possible."

In the operation of its airports, the Authority is directly responsible for providing at its airports the roads, car parks, terminal buildings and operational facilities such as runways, taxiways and aircraft stands. The BAA specifies the internal design and layout of its passenger terminals and provides facilities such as seating, toilets, flight information, airport information, baggage handling systems, lifts and escalators, and commercial activities operated by concessionaires such as bookstalls, banks, Post Office, restaurants, and gift shops. It also provides porters and trolleys to help with baggage.

No single airline has priority use of airport facilities. The BAA tries to ensure that the operational facilities check-in desks, baggage belts—are efficiently utilised so that the needs of each airline are met. Likewise, to fulfill its objective of easing the passage of travellers through its terminals, the Authority is sensitive to the operation of the statutory controls—Security, Immigration and Customs. Not to be overlooked are the public transport services to the airport—train, underground, bus and coach. It works therefore very closely with the airlines and control authorities, and the public transport operators to ensure for the passenger a smooth transfer between surface and air transport.

Responsibility for passenger sevice is shared between the Authority and the airlines. The airline, for instance, provides assistance with transportation through the terminal between check-in and aircraft on flight departure and from aircraft to baggage claim on flight arrival while BAA provides porterage between, respectively, forecourt and check-in and baggage claim and forecourt. While this is the general rule, at Gatwick, travellers with mobility problems can arrange with their airline or handling agent for transportation from the forecourt to check-in because a considerable distance is involved. At Prestwick, BAA is responsible for providing all passenger handling services.

The prominent role BAA takes in the running of its terminals and its involvement with passengers has meant that a visible and distinctive presence in the buildings with uniformed duty staff to indicate the availability of assistance is of top importance, particularly because in the last year or so, traffic growth has begun to push the Heathrow and Gatwick terminals to their capacity limits.

BAA's Policy Towards Handicapped Passengers

In view of BAA's role, its responsibilities for elderly and disabled passengers fall into two general areas, closely interrelated, namely the provision of convenient buildings and facilities and of associated services to smooth the way through the airport.

Functional building design is a vital ingredient in the planning a new passenger terminal. Criteria have been established for matching space requirements for facilities to passenger throughput. There is neither the money nor the space to provide more than is needed. Within tight constraints, provision for efficient passenger processing and flow through the terminal must be a feature in the design.

While that is the objective, it is inevitable that in a large terminal building designed for a throughput of, say, 8 million passengers a year with perhaps 80 percent travelling on international flights, that many elderly passengers and those with mobility problems may find, for instance, the walking distances between the terminal building entrance and the aircraft too great to manage. Other feature in the building can pose problems for those with other impairments—bright lights, reflective surfaces, pastel-shaded decor, signs and flight information boards; all present difficulties to the partially sighted. With the noise and bustle of a busy terminal, it can be difficult for the hard of hearing to follow verbal instructions. Even if the obstacles to the free movement of wheelchairs have been eliminated and lifts provided for changes in floor level, the restricted movement and reduced height of a person seated in a wheelchair pose their own problems and can be overlooked. These potential difficulties must be recognized and alleviated through design if possible or by the provision of assistance.

The BAA could be said to have had a policy for disabled people since 1968 when it published design specifications (BBA, 1968) for the provision of facilities for disabled passengers for use by its own engineering department, architects and consultants when planning and designing new airport buildings. It was based on a recently issued Code of Practice (BSI, 1967) but taking into account the particular features of airport buildings. Unfortunately the Authority inherited a number of old buildings on its formation in 1965 which were deficient in access provision and which have had to wait for redevelopment to provide standards. The first new passenger terminal to benefit was at Gatwick and, in 1976, it won the award (CCD, 1976) given by the Central Council for the Disabled, supported by the Department of the Environment and the Royal Institute of British Architects, for its facilities for the disabled. The building was held up as an example that other main transport termini could follow.

It must be admitted that the U.K. has lagged someway behind the U.S. in access provision. A leading British authority, the architect Selwyn Goldsmith (1983), has explained this in terms of cultural differences. The U.K. approach to designing for the disabled has reflected its concern for social welfare characterized by special treatment, discrimination, demand/response. This contrasts with the self-help ethic of the U.S. implying self-reliance, independance and equal treatment. Goldsmith, a strong supporter of the U.S. barrier-free movement exemplified by the American Standard of 1961 (ASA, 1961), advised the BAA in the preparation of its 1968 Specifications and has been a major influence in the evolution of BAA's policy. However, until IYDP, although we applied a policy of access provision, it was relatively low key and our standards have evolved by reacting as necessary to approaches from the disabled community. Air travel has been low on the priorities of disabled people in Britain who have been more concerned with their local transport needs. The Authority has however, taken the standards of the international air transport industry as its model rather than those of local and national transport undertakings.

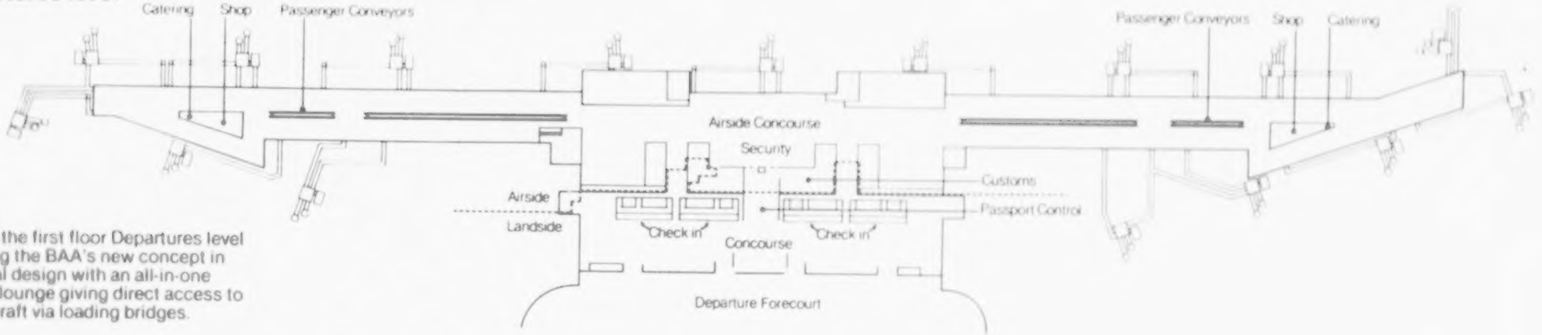
IYDP in the U.K. was fully supported by the Government and the transport industry. Along with its partners in air transport, BAA responded positively by redefining its policy towards the disabled to take into account the aims of IYDP. This involved re-examining building design specifications and, through training, creating a better awareness of the needs of disabled people. Although features in BAA's policy in the past, more importance has been given to understanding what disabled people want and to co-ordinating the Authority's approach with the government programme initiated in IYDP and with the efforts of related transport operators to fulfil the wider "door-to-door" travel needs (DOT, 1982).

This means providing for the needs of disabled people in the planning and design of airport buildings in the same way as is necessary for the owners/developers of all public buildings. It also means that provision must be related to the operational aspects of the airport and the requirements of the transport providers.

A consequence of the IYDP compaign has been a better appreciation of the range of disabilities. A disabled person, in the past, has usually been associated with a wheelchair. The international wheelchair symbol has been indiscriminately used to indicate facilities for the disabled. The BAA, regretfully, is not guilt-free as the symbol appears on the cover of its airport access guides published to benefit all handicapped air travellers. The symbol will no longer be used in this way when the guides are incorporated within a comprehensive information booklet to be published for each airport in 1985.

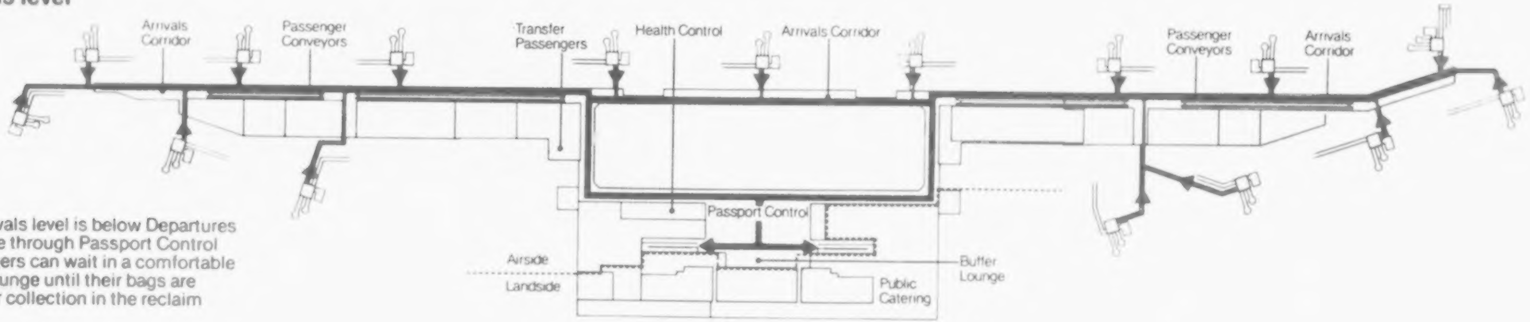
Although the size of the disabled population is not used by BAA for estimating demand for special facilities, there is an awareness that many travellers, particularly the elderly, would not regard themselves as disabled but yet may have problems finding their way around strange, large, busy airport terminals because of failing sight or hearing, or mobility problems. Generally, these

Departures level



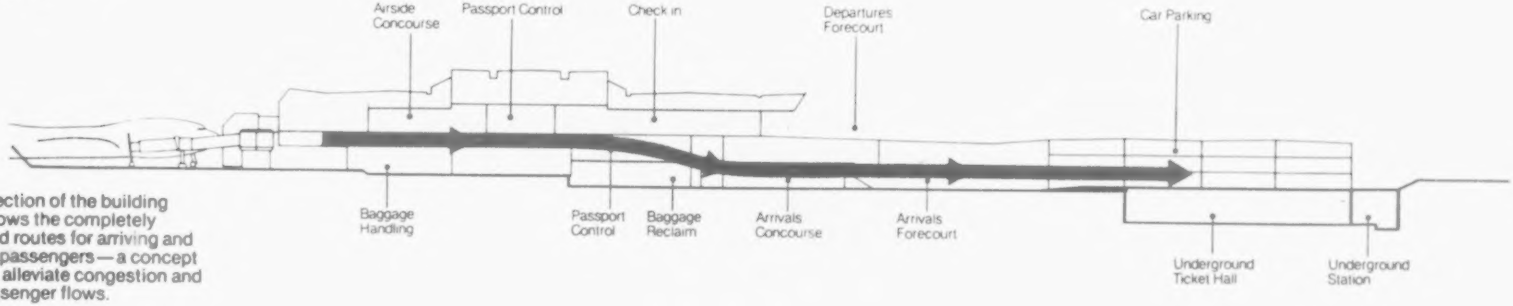
Plan of the first floor Departures level showing the BAA's new concept in terminal design with an all-in-one airside lounge giving direct access to the aircraft via loading bridges.

Arrivals level



The Arrivals level is below Departures and once through Passport Control passengers can wait in a comfortable buffer lounge until their bags are ready for collection in the reclaim hall.

Passenger flow



A cross-section of the building clearly shows the completely segregated routes for arriving and departing passengers—a concept which will alleviate congestion and speed passenger flows.

passengers appreciate and rely on some form of physical assistance from staff. This is in contrast to the younger, long-term disabled traveller who may be very fit—though, for example, blind—and values his independance. He will be distressed if a well-meaning staff member offers to push him through the terminal in a wheelchair. Although that incident would generally have involved airline staff, the principle is that passenger service training for duty staff must develop a sensitivity in distinguishing the approporate assistance to offer.

How the Policy is Implemented

The Disabled Persons Act, 1981 imposed a duty on developers of public buildings to take account of the needs of disabled people which, in effect, meant applying to building design the provisions of the 1979 Code of Practice (BSI, 1979) relating to access requirements for the disabled. These have been incorporated in an updated edition of BAA's design specifications (BAA, 1984) for facilities for the disabled which also reflect higher standards recommended by Selwyn Goldsmith (1976) and, wherever possible, the results of consultation with user-groups. Provision is made not only for handicapped air travellers but for all disabled people visiting the airport, including escorts and spectators.

Generally, satisfying the needs of disabled users benefits all users. Access to and circulation within the terminal buildings and multi-storey car-parks, for example, need to be provided for baggage trolleys and porters' barrows as well as for wheelchairs. Visual aids, such as contrasting colour stair nosings and clear unambiguous signing are safety and information features helpful to everyone. Some dedicated facilities are however necessary, such as unisex toilet cubicles and extra-width car parking bays.

At BAA's airports, all new buildings and those being redeveloped are being designed to comply with the latest specifications providing for disabled people. Car parking and pedestrian links between buildings are included. Proposals to introduce a new facility or aid specifically for the benefit of the disabled would be considered on the usual cost/benefit basis. Sometimes there are competing needs. In some BAA passenger terminals, flight departures announcements over the public address system have been discontinued to reduce the noise levels in the building. This has helped to create a more relaxed atmosphere for passengers and staff. However, this decision has not been welcomed by the partially-sighted who have argued that they rely on such announcements. The use of the public address system is an operational decision of terminal management based on local requirements, and any variations in its use are well advertised with alternative arrangements made for assistance by airline staff as necessary.

We consider that all essential requirements for providing access to elderly and handicapped travellers are met in the design specifications although we could not guarantee that some of the older facilities are as convenient to use as we would wish. Improvements to standards are continually made under regular general refurbishment programmes although no airport operates a specific budget for improving facilities for the disabled. A survey of facilities was carried out at each BAA airport in 1981, specifically to identify shortcomings and features which might cause problems for handicapped passengers. This resulted in considerable remedial work being carried out, often involving relatively low cost items such as curb cuts and fittings in unisex toilet cubicles. It is intended that a similar survey will be conducted approximately every three years although daily inspection by terminal duty staff will reveal urgent matters needing attention.

The new Terminal 4 at Heathrow, expected to be operational in 1986, provides a good example of how the concepts aimed at easing passenger flow have been applied. A main feature of the design is the complete segregation of arriving and departing passengers on different floor levels which will benefit wheelchair passengers. Another is the airside lounge providing immediate access via loading bridges to sixteen aircraft stands instead of the conventional system of a departures lounge, airside piers and gaterooms. It is expected that these features together with the simplicity in the design of check-in, passport and security control will make it considerably easier for the elderly and disabled to pass through the building which, in turn, will reduce their dependance on staff assistance.

Nevertheless, the presence of well-trained staff and other facilities to complement appropriate building design are features of passenger service provided by BAA particularly of benefit to the elderly and disabled. Some information staff have acquired skills in using finger language to communicate with the speech-impaired. Specific training is given to terminal duty staff on the needs of the disabled, with disabled contributors from outside BAA. A more thorough grounding in general passenger service requirements, in the style of that given to airline staff, in the "Please the Passenger" campaign introduced this year to get the message over to staff that only the very highest standards of service are acceptable to passengers.

Additional facilities provided at BAA airports include: baggage trolleys (without charge) for use between aircraft and forecourt; induction loops in departures lounges for hearing aid wearers linked to the public address system; seating reserved for the disabled; scissor-lift vehicles for transferring passengers in wheelchairs between ground level and aircraft door at BAA's Scottish airports where it is responsible for ground-handling equipment; and, at Heathrow, a tail-lift vehicle for transporting disabled drivers in wheelchairs between the long-term car-park and passenger terminals.

Having designed the airport buildings and taken measures to make them easy to use, the major task in BAA is to join with its partners in the industry to encourage elderly and disabled poeple to fly. Leading tour operators now include holiday programmes for the disabled and plenty of advice is available from specialized agencies. BAA plays its part by providing access guides for each airport with terminal building floor plans, indicating the location of principal facilities including ramps, lifts and restrooms with advice on how to arrange for assistance through the terminal.

Summary

In conclusion, it can be said that BAA, believes that it is well advanced towards achieving a standard of facilities and services at its airports which will meet the requirements of handicapped and elderly passengers. Facilities specifications have now been defined and are applied in the design of all new airport buildings while the older buildings are continually being up-graded to conform. A high priority is being given to staff training using the latest methods to ensure the best possible service to passengers. For the future, BAA's conern will be:

- to get feedback from the user on current standards;
- to be aware of improvements to standards within the air transport industry;
- and to publicize the facilities and services so that they are fully used by the people for whom they have been provided.

References

American Standards Association, American Standards Specifications for Making Buildings and Facilities Accessible to and Usable by the Physically Handicapped (A117.1-1961). New York: The Association, 1961.

British Airports Authority, Provision for Facilities at Airports for Disabled Travellers. Dept. of Engineering Report No. 6. London: BAA, 1968 (Internal Issue)

British Airports Authority, Annual Report and Accounts 1983/4. Gatwick: BAA, 1984.

British Airports Authority, Facilities for the disabled. Gatwick: BAA, 1984 (Internal issue).

British Standards Institution, Code of Practice for Access for the disabled to buildings, Part 1, General Recommendation (CP96:1967). London: the Institution, 1967.

British Standards Institution, Code of Practice for Access for the disabled to buildings (B.S. 5810.79). London: the Institution, 1979.

Central Council for the Disabled, Building for the Disabled, 1976—Awards report. London: CCD, 1976.

Department of Transport, Door-to-Door—A guide to transport for disabled people. London: Her Majesty's Stationery office, 1982.

Selwyn Goldsmith, Designing for the Disabled. London: RIBA Publications, 3rd Edition, 1976.

Selwyn Goldsmith, The ideology of designing for the disabled, in Design for Special Needs. London: Centre on Environment for the Handicapped, No. 31, May-August 1983.

Alistair G. D. Matson, Facilities Planner, British Airport Authority, Gatwick Airport, Gatwick, England, RH6 OHZ

AVAILABLE RESEARCH ON DISABLED AND ELDERLY AIR PASSENGERS

Ellis Reida

Introduction

In the fall of 1977, when the initial approaches were made to the air carriers concerning attention to air travel for disabled people, the carriers asked a simple question: "How many people are we talking about?" Seven years later in 1984, after the industry has made great strides in making its air fleets accessible, it is still impossible to answer that question.

This lack of information is made more critical by the fact that the airlines hold a central and crucial position in meeting the mobility needs of disabled and elderly people. During those first months in 1977, at open meetings, the attention of the disabled in attendance was on the carriers, rather than on trains and busses. In recent months, in hearings in the United States House and Senate, when the topic was travel for the handicapped, the spotlight was on the problems of airline service.

The reason for this concern on the part of disabled and elderly people about accessibility of air travel would seem to be both pragmatic and psychological. We now live in a world increasingly mobile. Not to be able to get "from here to there" severely restricts not only employment but leisure activity, and one's ability to perform as a functioning member of society. And increasingly, the best, and sometimes only, way to "get from here to there" is by air.

There appears to be a belief that the airliner is the single most expensive item of equipment used in travel, and it is therefore the most difficult to re-engineer and redesign for accessibility purposes. Space, safety, weight, cost, and air-worthiness are only some of the unique constraints in addressing the problem.

Organizations of disabled individuals, and those who serve them, perhaps see the airliner as the key link in making the whole travel chain accessible. It is clearly understood that the chain is comprised of the home to airport link, the airport, the aircraft, accommodations, and accessibility to business or recreational areas of the host community; all elements have to be barrier-free. Any blocked link severely diminishes the utility of the entire system. The airliner seems a formidable block, and as such is a symbol of inaccessibility for the disabled.

Although it is impossible, even today, to answer the airlines' question, "how many people are we talking about?", with data which are conclusive and acceptable to market research statistical analysis, it may be possible by looking at some research findings to provide relevant insights into the present and potential market in air travel of disabled and elderly people. This would encourage the industry to expand services, and in spite of the lack of precise statistical data. It may also encourage the development of future studies to collect more precise information.

This paper, therefore, will review the relevant literature on general population statistics relating to the disabled, and will try to ascertain whether any data accumulated are useful to the topic at hand.

Early Population Studies

Following World War II, pressure for the development of services for the disabled increased greatly, and governments began to understand that little was known about the numbers of disabled persons or the categories of need. Beginning in the late 1960s, a number of studies took place in Europe and the United States to elicit basic information.

Most of these studies are out of print and very difficult to obtain. However, Bintig (1981) has done a valuable service by collecting these studies and reporting their findings in some detail, as well as describing critically the content and organizaton of the studies. His work is a basic resource for information on these earlier disabled population reviews.

Unfortunately, the studies per se do not add greatly to the store of knowledge about the disabled population of the various countries in which they were conducted. For example, one Austrian study in 1976 listed 21.4 percent of the population as handicapped. On the other hand, a 1970 census in Belgium estimated only 1.7 percent of the population fell into this category. Other studies showed the percentage to be 5.4 percent in the Federal Republic of Germany in 1976, and 8.7 percent in The Netherlands in 1971.

Such data are, for all intents and purposes, useless in any attempt to obtain universal population statistics relating to the disabled. Not only did the definition of disability vary for each study, but different sampling methods were used. In most cases respondents were asked to state their own perception of their disability. In some studies, respondents seemed to connect answers to possible eligibility for government services, and there are indications that they either understated or overstated disability to conform to such perceived eligibility.

The United Kingdom reports numerous statistics on the disabled population. A problem exists in that the data were collected by the Department of Health and Social Services and only those disabled persons who have applied for a government service are listed. It is broadly acknowledged in the literature that the totals grossly under-represent the disabled population in the UK; one researcher estimated that only 5 percent of the total reported as registering voluntarily (Townsend, 1983).

Random Selection Surveys: The Problem With The Data Base

Although accurate and sophisticated population sampling techniques have been available since World War II, it was only in the late 1970s that governments began to use these techniques to get more accurate statistics concerning the disabled populations in their respective countries. Each had a national census at regular intervals, and pressing questions were answered based on census data.

However, questions about disability were never part of the census in most countries. For example, it was not until 1980 that the United States census collected limited information in this area. It thus became necessary, when accurate information was needed, to undertake interim sample population studies.

However, another problem arises. Even though most more recent studies have conformed to the best standards of scientific measurement, and when taken alone offer accurate data, the data base from study to study vary, and thus information often cannot be usefully cross-correlated.

For example, the Social Security Administration collects information on the disabled population in the United States between the ages of 18 and 64. The U.S Census collected information in some categories in 1980 from the age of sixteen. The Urban Mass Transit Administation, on the other hand, did an extensive survey in 1977 of those five years of age and over. The on-going National Health Surveys in the United States also report data from those five years and older.

In some national censuses, respondents were asked for their own perception of their disability. Further, in most studies travel problems were not addressed as such. The primary emphases were on categories of disability and the severity of handicap. This focus presents a major problem for using data from the otherwise excellent National Health Surveys.

Analysis of Two Studies

Given all these difficulties, it is necessary here to restrict the evaluation of such studies to those having a similar data base, and which, at least tangentially, address the problems of travel. Two such studies meet these criteria, and offer the additional value of measuring the disabled in two countries distant from one another. They are the Urban Mass Transportation Study of 1977 (UMTA, 1978) in the United States, and the Handicapped Persons—Australia Study of 1981 (Cameron, 1982). The Australian study does not focus on travel; like the U.S. National Health Surveys, it offers a general population overview. However, it does look at people who are "mobility impaired."

The sample of the Urban Mass Transportation Study in 1977 consisted of 42,349 people in 15,704 households in the U.S., out of which 2,392 persons were identified as having disabilities which hindered their ability to use public transportation. While both institutionalized and non-institutionalized persons were interviewed, the sample of institutionalized disabled persons was only 295, which may have been too few to make precise statistical statements. However, for the purposes of this paper, non-institutionalized disabled persons are more relevant, and that portion sample was adequate.

The study estimated that a total of 7,400,000 people in the United States in 1977 over the age of 5 had problems which interfered with their use of public transportation, or about 5 percent of the total population. Some of the problems identified were inherent barriers, problems in service, and fear of traveling alone.

The Australian study was exceptionally well executed. The sample consisted of 33,000 households, and was one of the first such studies to use the World Health Organization Classification of Impairments, Disabilities and Handicaps (WHO, 1980) for definition of disability. Further, the study was divided into two parts, with the institutionalized and non-institutionalized population reported separately.

The results identified 1,153,600 disabled persons out of a total population of 14,540,000. Of these, 812,800 non-institutionalized disabled persons (5.6 percent) were what was termed "mobility impaired," that is, those persons having difficulty using public transportation, moving about the home, walking 200 metres, or walking up and down stairs. While there are a number of variables in this study which are different from those of the UMTA survey, this figure correlates closely to UMTA's 5 percent figure, and thus appears to approximate the same population group.

With respect to the elderly disabled, there was variation between the studies, primarily because of different category definitions. In Australia a total of 369,200 (32 percent) of the disabled were found to be 65 and over. Of this number, 168,000 were termed to be "severely handicaped" (40.8 percent) and 39.3 percent to have mobility handicaps. The UMTA study found 47 percent of the disabled to be 65 and over, and 67 percent to be 55 and over.

Other studies confirm the high percentage of the elderly in the disabled categories. The U.S. National Health Survey for 1980 found the number of elderly in the "severely disabled" category to be 50.9 percent. The 1982 figures for those who had registered for services in the United Kingdom found 596,000 out of 943,000 to be 65 or older (Ninnescah, 1983). However, as earlier stated, these figures are not considered representative of the disabled population as a whole.

With these data, imperfect as they are for the purposes of this paper, some statements usefully can be made concerning the percentage of disabled air traveler of at least these two countries, and its implications for developed countries. We now can say with some confidence that of the total population those who have trouble using surface transportation are approximately 5 percent, and of this group approximately half are 65 years and over.

In no study so far, of course, has the question of air travel been raised, and it is held by most experts that the segment of the population which does fly, tends to be biased toward those who have better jobs, higher income, and better education. Also, it is generally understood that disabled populations as a whole tend to have less income, lower employment levels, and less education than the population mean. Thus, surface transportation usage data is likely to be unreliable as a possible guideline to size of the travelers by air.

The two studies examined in detail, as well as the others which were reviewed more superficially, do, indeed, show the disabled population to have less income and less education than the mean of the population.

However, this truth can obscure another finding, that a certain pecentage do fall into categories which supposedly make them potential air travel customers. The UMTA study found 29 percent of the disabled who were sampled came from households in 1977 with incomes of $10,000 and up. The Australian study found 27 percent. The 1980 National Health Survey found 35.5 percent in this category.

As far as educational level was concerned, the UMTA survey found 39 percent to have completed high school. The Australian study found 28.2 percent with "post school qualifications" (i.e. to have completed 16 years of study).

It is, of course, obvious that disabled persons who fall below these levels can also easily become air travelers, and that many with high income and education will not travel. However, there is a strong probability that the figures do indicate to the airlines that there actually is a pool of disabled persons with adequate education and income, from a statistical point of view, to be considered as a potential market of some significance.

Other data which are useful to report and which provide a major focus of airline service to the disabled (primarily because of equipment design and operational stress) related to passengers in wheelchairs. Airlines are apt to judge the level of the disabled passenger load by the number of wheelchair passengers that they carry.

While it is important to develop such services, including the necessary accessible designs, it is also important not to lose sight of the fact that the total disabled population which needs travel services is much larger, and that many such categories of other disabilities have many times the number of potential and actual air passengers as those who are in wheelchairs.

For example, the UMTA study found only 5.5 percent of those who had trouble using public transportation to be in wheelchairs. The Australian study found 4.7 percent to be in this category.

On the other hand, the UMTA study found 21.1 percent to have severe hearing problems, and the Australian study 20.3 percent. The UMTA study listed 20.0 percent have visual problems, and the Australian study 11.8 percent (the difference between these last two figures is unexplained).

Implications of the Data

Thus, data presented from these somewhat parallel research efforts indicate that one can say with some confidence that one to two percent of the population of these two countries, as a whole, are both disabled, and actual or potential air travelers. For the United States, in rough numbers, it would mean between 2.5 and 5 million people.

One can also make reasonable assumptions that such percentages will tend to be relevant for the developed countries as a whole. If so, then the actual and potential disabled air passenger load can fall between 10 and 20 million people.

Complicating Factors in Load Estimation

There are other factors which both complicate and possibly dramatically increase the potential passenger load for those air carriers which offer accessible service.

One is the "multiplier" factor. It is a fact that a certain number of disabled air passengers travel with companions or relatives. And it can be assumed that the group as a whole will tend to choose the airline with accessible designs and better services for the disabled member of the group.

The only study so far which demonstrates this factor is a Republic Airlines survey (Rehabilitation International, 1983) which had numbers too small to be statistically significant. This "straw poll," however, showed an average of 1.4 companions accompanied each disabled air traveler interviewed.

When the "companion" factor, whatever its actual percentage number, is added to the disabled passenger potential already identified, the total passenger load potential is increased, perhaps significantly.

There are two other possible factors which can further complicate the issue. One is a finding by the United States Health Surveys that between 1969 and 1977 the percentage of severely disabled perople in the total population increased 40 percent.

Finally, there is a possible factor which relates directly to the airlines, themselves, and which has received no attention at all. It is only in the last 20 years or so that air travel has become a mass industry. Literally tens of millions of people have learned to travel by air.

A considerable mass of people is aging, and is beginning to move into retirememt; they have the income, the need and the "training" to continue to travel by air.

However, like many of us, this aging group is beginning also to acquire disabilities which accompany the aging process; such as heart conditions and stroke. Increasingly, therefore, it is predicted that members of this special "new" disabled group will present themselves at airport gates and expect their favorite airlines which they have used for years, to provide accessible services so they can continue to fly.

Conclusion

To conclude, this paper had two objectives. First, by presenting data from relevant studies, and to identify factors which can influence air travel by disabled and elderly passengers, thus demonstrate that there actually is a large market to be tapped. Service to elderly and disabled persons should not be only a response to possible public relations needs and pending new regulations, but also to serve a positive and potentially profitable market.

The second objective was to attempt to stimulate governments and other responsible agencies to undertake research in the area of air travel for the disabled which will provide hard numbers, discrete categories, and clear definitions of need, so that the airlines can more effectively offer relevant service to a major sub-population requiring immediate attention.

References

Bintig, Arnfried, "Statistics of Handicapped Persons in Europe," pp. 315-322, International Journal of Rehabilitation Research, 4(3) 19s1, G. Schindele Verlag, Rheinstetter, West Germany. This article has an excellent bibliography of original sources.

Townsend, Peter, Unpublished Paper, London, 15 August, 1983.

National Survey of Transportation of Handicapped People, a Summary Report, U.S. Department of Transportation, Urban Mass Transportation Administration, Washington, D.C., June, 1978.

Cameron, R.J., Handicapped Persons Australia 1981, Australian Bureau of Statistics, Canberra, Australia, 1982.

International Classification of Impairments, Disabilities, and Handicaps, A Manual of Classification Relating to the Consequences of Disease, World Health Organization, Geneva, 1980.

Ninnescah International Service, unpublished study, New York, 1983.

Proceedings: Second International Meeting, Access to the Skies Program, Rehabilitation International USA, New York, 1983.

Ellis Reida is President of Ninnescah Corporation, New York City, New York 10163.

5

Application of Microcomputer Technology to Specialized Transport

THE APPLICATION OF COMMERCIALLY AVAILABLE SOFTWARE TO PARATRANSIT MANAGEMENT

Marc R. Cutler and Lawrence J. Harman

Introduction

The purpose of the project reported in this paper was to select and apply commercially available software to paratransit management. While the focus was on data base management software (DBMS), other popular applications programs such as spreadsheets, word processing, and graphics were also investigated. The specific management functions considered for automation included vehicle scheduling; client and vehicle record-keeping; financial management, and report generation for billing and performance measurement.

Using actual data from a paratransit system (Call-A-Ride) which operated in Barnstable County, Cape Cod, Massachusetts, prototype data base was developed. The selected software was used to automate this data base. The final product was a User's Manual which was intended to assist non-technical transit managers in applying generic software products to the specific problems of paratransit management.

This paper summarizes the lessons learned by the authors during the course of this project. For the sake of brevity, we will discuss only the application of the data base management software (DBMS), and focus on its application to the scheduling function. The software selected was Microrim's R:base 4000.

Software Selection

The first task of the transit manager contemplating automation is the selection of an appropriate piece of software. Several factors need to be considered:

- What is the level, or realistically-potential level, of data processing capability within the organization?
- How willing is the organization to devote time and resources toward developing this capability in-house?
- How willing is the organization to acquire such assistance?
- How sophisticated a product, particularly in terms of integration and computational capability, is required?
- Should the software be generic (and hence multi-functional) or dedicated to specific tasks?

The first three questions all relate to the issue of "ease-of-use." All DBMS's are complex programs requiring far more effort to master than a spreadsheet program. We found it convenient to group products into three categories:

1. File Managers (i.e., Advanced DB Master, Lotus 1-2-3). These are the simplest type of DBMS's to learn. Their main drawback is that they do not permit the interaction of data from different files.

2. Relational DBMS's which can be used Off-the-Shelf (i.e., R:base, Open Access, Sensible Solution, Condor). These products are more complex than file managers but more powerful in that they can interchange data between files. For example, it is possible to update simultaneously a common field such as client ID number which appears in several files.

3. Programming Language (dBase II, Knowledgeman, Probase). These products have similar capabilities as the relational DBMS's described above, but they must be programmed by data processing professional to be used for specific applications.

Figure 1 outlines the characteristics of these and other similar programs. All of these programs were developed for generic business applications. They could just as easily be used in a widget factory as in a paratransit agency. Their documentation is, therefore, non-application specific. The problem for the transit manager is not only to figure out how to use the product generally, but how to apply it specifically to his or her problems.

We selected R:base 4000 because of its desirable (though not essential) relational features and its potential for actual off-the-shelf use by non-data processing professionals. The intent of the manual was to serve as a "bridge" between the generic documentation and the transit manager. The process of developing this manual has convinced us that a significant level of data processing knowledge still is required for use by the transit agency in a true off-the-shelf (without the assistance of a consultant) fashion.

The programming languages cannot be utilized off-the-shelf. Ironically, once they are programmed (a process called customizing), the final product is easier to use than the off-the-shelf products. The customized product is typically a series of menu-driven choices requiring only repetitive (as opposed to intuitive) learning on the part of the users. Many of the "off-the-shelf" packages (including R:base 4000) have developed customizing features and thus can be used in either fashion. The programm-

82

NAME (MANUFACTURER)	TYPE	REC./ FILE	FIELDS/ REC.	CHAR./ FIELD	OPEN FILES	DATA TYPES	DATA PROTECTION	INTEGRATION	EASE OF USE	PRICE
DB MANAGER II (Alpha Software)	File Mgr.	100,000	40	60	1	A,N,D	N/A	Read/Write	Easy	$295
ADVANCED DB MASTER (Stoneware)	File Mgr. (*)	1,000,000 (+)	250	220	1	A,N,D	Yes	Read/Write	Easy	$495
T.I.M. IV (Innoative Soft.)	File Mgr.	32767	40	2400	1/2	A,N,D,$ Other	Password	Read/Write	Easy	$495
R:BASE 4000 (Microrim)	Relational	2.5 billion (+)	400	1530	40	A,N,D,$	Yes	Read/Write	Easy	$495
KNOWLEDGEMAN (MDBS Systems)	Relational	65535	255	65535	Unlim.	A,N,D,L	Yes	Spreadsheet Read/Write	Difficult (Language)	$500
OPEN ACCESS (S.P.I.)	Relational	32000	55	40	5	A,N,D	N/A	Integrated	Easy (+)	$595
CONDOR 3 (Condor)	Relational	65534	127	127	2	A,N,AN,D Other	N/A	Read/Write	Somewhat Difficult	$650
PROBASE (Data Technology)	Relational	65535	64	64	3	A,N,D	N/A	N/A	Difficult (Language)	$650
SENSIBLE SOLUTION (O'Hanlon)	Relational	16 million (+)	384	255	10	A,N,D	Yes	N/A	Difficult	$695
dBase II (Ashton-Tate)	Relational	65535	32	254	2	A,N,L	No	N/A	Difficult (Language)	$700

NOTES:
(*) = Sophisticated File Manager
(+) = Claimed by manufacturer

Data Types:
A = Alpha
AN = Alphanumeric
N = Numeric
D = Date
$ = Dollar
L = Logical

FIGURE 1. SUMMARY OF DBMS CHARACTERISTICS

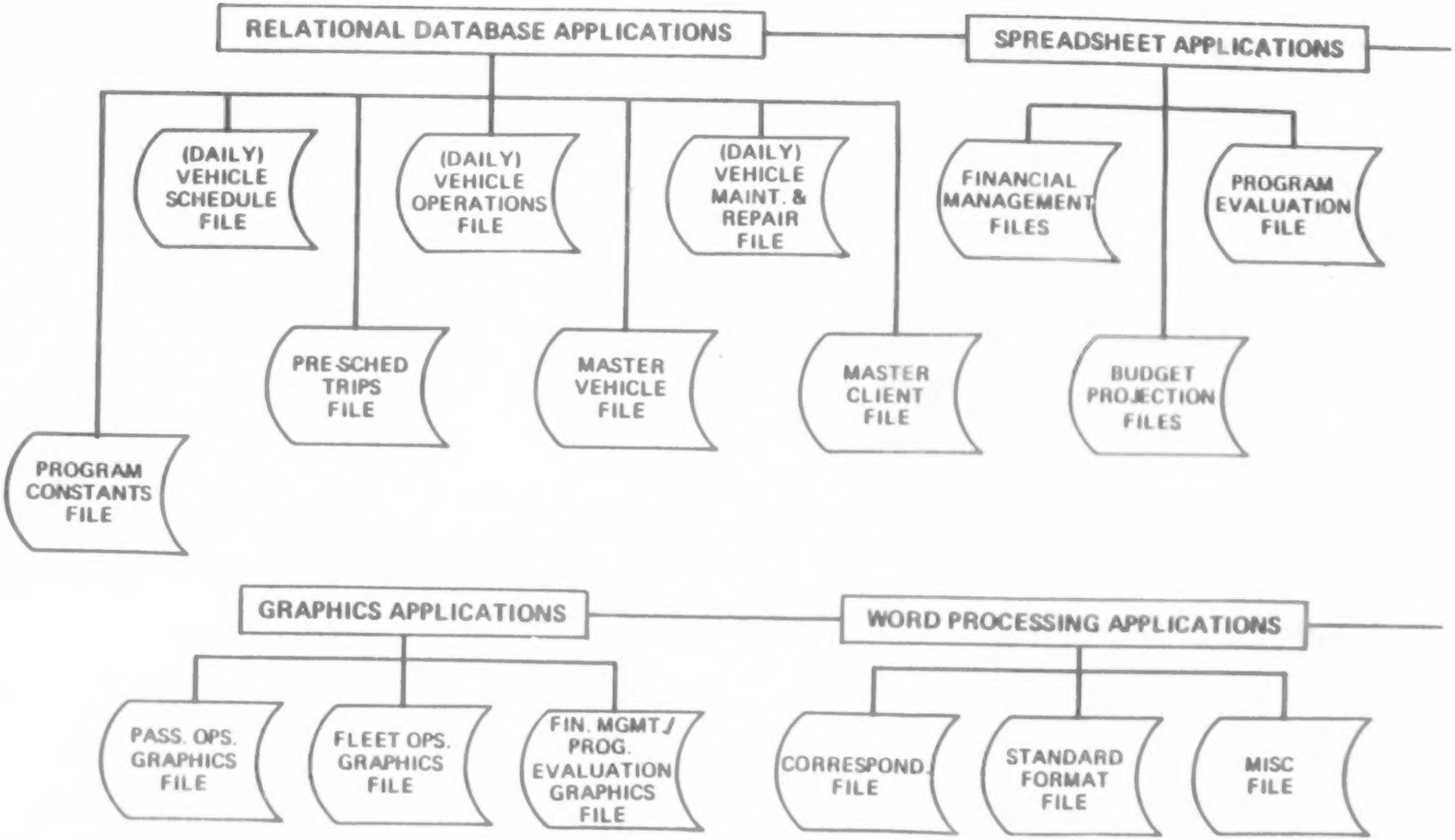


FIGURE 2. CONCEPTUAL DESIGN OF MICROCOMPUTER APPLICATIONS

ing languages must be customized. The transit manager must determine whether or not his/her needs merit the expense, resources, and time required of the customized approach. We believe that many needs can be met by the relatively easy-to-implement, unsophisticated R:base, or even File Manager, approach.

Integration is another area where there is a legitimate question of how much sophistication is required. Programs like Knowledgeman and Symphony integrate in one package graphics, spreadsheet, and DBMS capabilities. This results in a program which cannot only manipulate text (the traditional function of a DBMS) but also can perform powerful mathematical computations. It is our feeling that integration should not be sought at the expense of ease of use, unless it is essential. For example, we used R:base and a spreadsheet program concurrently, moving data from the DBMS to the spreadsheet manually and only where necessary. This could be done automatically within Knowledgeman but few paratransit agencies possess the data processing expertise to use Knowledgeman without significant outside assistance. In our view, the trade-off is not worthwhile unless the agency has a substantial need to transfer data between the different kinds of programs.

The final issue concerns the use of generic versus functionally-specific software. There are programs specifically designed to manage accounting systems, prepare payrolls, and calculate income taxes. They are easy to use and require little intuitive intervention on the part of the user. The disadvantages of this approach are twofold:

1) the programs tend to be inflexible and often incapable of modification to meet the unique needs of a transit agency; and

2) they will function in a complete stand-alone fashion.

Our conclusion is that agencies should not select the most sophisticated technology just because it exists. They should balance their needs against the resources available for learning to use a specific product.

Designing a Data Base

Once the DBMS software has been selected, the first step in its application is the conceptualization of a data base. For a transit agency with a poor manual record-keeping system and little data processing expertise, the process can grind to a halt at this point.

Figure 2 displays a sample conceptual design, including spreadsheet, graphics, and word processing applications. We will be concerned only with the files in the upper left-hand corner under "Relational Database Applications." Each file is discussed below.

In its simplest form, a DBMS functions like a file drawer, enabling you to store records in files and extract only those you want to see for a specific purpose. A relational DBMS, as opposed to a file management system, recognizes the relationships between data in different files. Figure 3 displays the structure of a DBMS.

Data Base

File No. 1		*File No. 2*	
Field No. 1	Field No. 2	Field No. 1	Field No. 2
(record No. 1)		(record No. 1)	
(record No. 2)		(record No. 2)	

Figure 3. DBMS Design

A relational DBMS is capable of manipulating fields and files in two unique ways. First, separate files containing common fields can be merged, allowing access to a great deal of related data at one time. For instance, a daily vehicle operations file and a vehicle maintenance/repair file, each including a field for vehicle ID number, could be joined in order to determine operating cost by vehicle. Or, a vehicle schedule file containing a client ID number could be merged with the master client file, also containing a client ID number, to develop detailed information on the ridership activity of specific clients for billing purposes.

Second, changing a field in one file in a relational DBMS automatically causes all identical fields in all other files to be changed accordingly. Thus, changing or updating a field that appears in several files, such as client ID number, can be accomplished with a single command.

The files to be created and maintained in the relational DBMS are as follows:

Master Client File: A list of all present and past paratransit service users, including such pertinent data as address, telephone number, age, passenger classification, Medicaid number, human services agency authorization, and special instructions.

Master Vehicle File: A record of all vehicles purchases, including license number; serial number; year, make, and model; engine size; owner; conversion information; and purchase date.

Pre-scheduled Trips File: A "dummy" file for a day(s) of prescheduled trips for all regular clients, which can be edited (to alter individual vehicle assignments and service date) and merged with the active data base to be used in the preparation of daily vehicle schedules.

Daily Vehicle Schedule File: A record of daily vehicle trips created as they are called in, including client ID number, desired pick-up and drop-off times, origin and destination addresses, passenger classification, trip purpose, and special needs.

Daily Vehicle Operation File: Daily operating statistics for each vehicle in service, including driver and vehicle

ID numbers; starting and ending mileage; start time and end time; quantity and cost of fluids used; necessary repairs or road calls; and contract vehicle hours. The vehicle operations report is filled out by each driver during his/her daily run and entered into the data base later.

Daily Vehicle Maintenance and Repair File: A record of maintenance and repair performed on each vehicle, including a description of work done, cost of parts and labor, and vendor.

Program Constants File: Contains frequently used data such as origin and destination codes, trip purpose codes, vendor codes, and mileage between common origins and destinations.

These files would be used alone and in combination to produce driver itineraries, client/agency invoices, and management tools such as operations reports, vehicle maintenance reports, and ridership reports.

Once the user selects the desired files, the structure of each file must be designed. This should be done manually first. Although most programs permit redesign later, the process is not always as easy as one might desire, as was the case with R:base. The user must first determine what data is important enough to the way they operate to require a field in a specific file. This step requires a great deal of user judgement. Each desired data field must then be designed, requiring the user to make the following choices:

Type—Will the field contain numbers, words, decimals, etc.?

Length—What will be the maximum data entry in the field?

Name—What will the field be called within the program?

Key—Will there be special access through the field?

Finally, if the data base is relational, the user needs to consider how individual files will relate to each other, e.g., what common fields will appear in different files?

Clearly, even using an "easy-to-use" product such as R:base requires considerable decision-making on the part of the manager, and a familiarity and confidence with fundamental data processing concepts.

Implementing Automated Scheduling

Automated scheduling is a broad term which covers two very different applications. It can be used to refer to the automation of the data needed to permit a clerk/dispatcher to schedule a trip, or to the development of a software algorithm which automatically computes the various iterations and assigns the trip to the "best" option with little or no human intervention. We used R:base to perform only the data automation function. Considerable UMTA-funded research is being conducted on the development of paratransit scheduling algorithms.

The difference in approach is largely one of emphasis. The automation of the data base provides the human scheduler with accurate, up-to-date information upon which to make judgemental decisions. The development of algorithms naturally tends, over time, to automate the decision-making process and minimize the discretion of the human scheduler. Both approaches have validity depending on the characteristics and size of the transit operation. Discussions on the merits of each approach tend to mirror similar discussions regarding the benefits of automated scheduling among fixed route providers. Generally speaking, manual scheduling remains predominant among fixed route operators with fewer than one hundred revenue producing vehicles. A similar, informal cut-off point will likely emerge as research on paratransit scheduling algorithms proceeds. It is important to realize that this work is still in its early stages, roughly equivalent to that of the first RUCUS models a decade ago.

In addition to the overall size of the paratransit operation, a second significant consideration in determining the agency's approach to scheduling automation is its mode of operation. Specifically, is the agency's goal to preschedule the majority of its trips or to provide "real-time" service? By the latter, we mean that callers can request service at any time, with no advance reservation requirements.

Traditionally, most paratransit agencies have required a minimum 24-hour advance notification for a client to be guaranteed service. This preference reflects the development of paratransit service out of the human services model with a relatively stable, and known clientele. The prescheduling model best serves the regular rider. The occasional rider must fit into a sechdule built around the needs of the regular user. Most of the riders of this type of system will be regular users and should receive priority service. Since the emphasis of the system will be on prescheduling (and no true real time scheduling will likely occur due to the imposition of a minimum advance request standard), there is no great need for a scheduling algorithm. This model values the predictability/reliability element of fixed-route service most highly. Regular users know that they can depend on the system to provide the same service each week.

The real time model places the occasional user on an equal footing with the regular rider. This is more appropriate as the system moves towards a more truly "open to the general public" status. The real time model accommodates the lack of advanced trip planning on the part of the rider in a manner similar to a fixed route system. Like a fixed route, the customer need make no advance decision to use the system. Depending on system size, scheduling algorithms may prove quite useful in this type of operation.

The goal of our automation was to provide the human scheduler with the information needed to make an informed, judgemental decision. This was accomplished in the following manner. Two scheduling files were established. A "dummy" preschedule file was created to act as a repository of all monthly prescheduled trips (i.e., Mrs. Jones always goes to the nutrition site at 11:00 a.m. on Mondays, Wednesdays, and Fridays). This file contained all relevant trip information (pick-up and drop-off times and location, passenger data, etc.) except trip date. The daily trip file contained all random advance trip requests not included on the preschedule file. The preschedule file would be updated at the beginning of each month. The daily file would be updated as trip requests were telephoned in to the agency.

The "dummy" preschedule file would then be used as a base from which date-specific preschedule files could be created. The exact method of doing so depends on the agency's operating procedures. For example, if the agency has a unique trip pattern for each day of the week, five unique preschedule files could be created. On the other hand, if the agency has a M-W-F and T-Th trip pattern, only two such files would be needed. Of course, these files will need to be edited from time to time as regularly schedule trips are canceled or altered.

Upon reaching the deadline for the receipt of advanced reservation requests for a specific date, the agency would merge the preschedule and advance request records for that date, creating a master vehicle schedule file. from this file, individual vehicle schedule reports, as shown in Figure 4, could be created and sorted by pick-up time. This report would function as driver itinerary. As this process repeats itself each day during the month, the master vehicle schedule file becomes the repository for all trips taken during the month, and forms the basis for the generation of end-of-the-month reports ranging from agency bills to performance measurements.

In this system, all trips will be scheduled based on the judgement of the clerk/dispatcher. The prescheduled trips will form the framework of the service pattern, almost approaching a fixed route schedule, while the individual advance trip requests are fit into this pattern. Upon

Vehicle No: A1
Date: 05-07-79

Time	*Last Name*	*First Name*	*Address*	*City*	*Destination*	*RT Time*	*Class*	*Purpose*	*Special Needs*
700	Allen	Helen	50 Lawtner	Centervle	Dialysis		eh	dl	
700	Sandman	Theresa	1507 Vinewood	Hyannis	Dialysis		h	dl	structure
900	Tower	Nicholas	27 Breaker	Pocasset	BCH	1500	weh	adc	
900	Craig	Helen	79 Sidney	Falmouth	BCH	1500	eh	adc	medication
900	Sherman	Milton	1 Cold Ridge	Bourne	BCH	1500	e	adc	medication
900	Barrett	Robert	66 Kenwood	Falmouth	BCH	1500	e	adc	
915	Lapon	Peter	1501 Beacon	Falmouth	BCH	1500	eh	adc	

Figure 4. Sample Vehicle Schedule

Last Name	*First Name*	*ID*	*Address*	*City*	*Class*	*SpecNeed*	*Med ÷*	*XX$*	*Units*	*Term Date*	*Term Why?*	*Edit Date*
Abbott	Catherine	0064	9702 Bridge	Yarmouth	e	no phone				05/31/79	moved	05/31/79
Allen	Helen	0146	50 Lawtner	Centervill	eh		628982					05/08/79
Allenson	Herbert	0154	55 Rustown	Cotuit	weh			251753	30	09/30/79		05/14/79
Aries	Rose	0077	15 Fringewood	Dennis	e	medicatio						05/03/79
Armas	Marie	0071	12 Snow	Dennis	e							05/03/79
Auld	Grace	0031	27 Tealford	Dennis	eh		019952	275743	22	08/31/79		05/15/79
Auld	Nellie	0149	108 SanMarcus	Falmouth	eh		043904	956433	34	09/30/79		05/11/79
Availon	Kathleen	0072	1 Vickie	Dennis	e	structure						05/17/79
Baker	John	0001	65 Bass	Dennis	e							05/01/79
Barrett	Robert	0129	66 Kenwood	Falmouth	e		293173					05/11/79

Figure 5. Sample Master Client

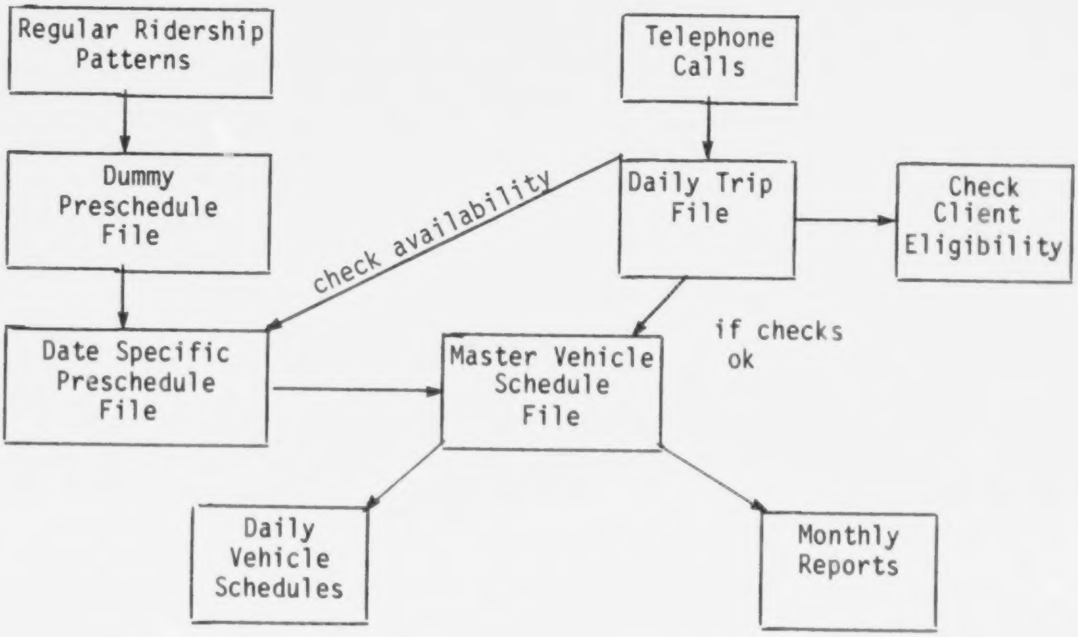


Figure 6. Summary of Schedule Automation Process

receiving such a trip request, the scheduler can simply book it based upon knowledge of the routing and service availability patterns. The scheduler may, however, call up on the screen any vehicle schedule-in-process to check on trip availability or to determine which vehicle provides the most desirable option. This can be accomplished interactively with the client on the telephone. In a manual system, the time needed to check on availability, particularly if several routings must be checked, might often require a call-back.

In addition to checking on trip availability, the scheduler may also want to check on client eligibility. This can be accomplished in one of two ways. In a small system, each scheduler could be provided with a hard-copy print-out of the client master file (see Figure 5), sorted either by client ID number or alphabetically by last name. In a large system with many clients, it will be desirable to call up a specific client record on the screen. We found that normal R:base procedures were too cumbersome to enable a scheduler to do this on-screen interactively with the client on the telephone. This function would need to be customized, setting up a menu-driven series of commands. Even given the relative simplicty of R:base's customizing procedures, performing this task would require familiarity with data processing programming concepts.

The advantage of this customizing approach lies not only in its speed, but also in permitting the scheduler to update/edit the client record based on new information supplied by the client on the telephone. The clear advantage of performing these functions interactively is the elimination of time-consuming and embarrassing ("we regret to inform you . . .") call-backs. This process is summarized in Figure 6.

Conclusion

Several points need to be made about implementing an automation process. First, as mentioned above, we found some of R:base's procedures and sentence-structure too cumbersome to perform some functions in a sufficiently user-friendly manner without customizing.

Second, R:base presented unanticipated capacity problems. Unlike some file manager programs, such as Advanced DB Master, R:base does not permit interaction between different data disks. This requires the storage of an entire data base on a single floppy disk. We found this adequate for only two weeks worth of data for a five vehicle system (estimates vary depending on actual ridership). Clearly, this is inadequate given the usual premium on maintaining monthly records. Even functioning in this manner required an unpleasant amount of deleting and reloading. The only solution for all but the smallest operations would be a hard disk. This problem was completely unanticipated despite our extensive research on software products.

Thus, the process of adapting a generic piece of software (even one as truly user-friendly and flexible as

R:base) to the specific demands of paratransit management was not an easy one. No paratransit agency without significant data processing experience could have done it simply by using the generic R:base documentation. We strongly believe that the manual developed by this project will serve as the bridge betwen the user and generic documentation, and is broad enough to be applied to programs other than R:base. Nevertheless, some data processing expertise will still be necessary.

Finally, despite conducting an extensive software search, R:base still presented us with unanticipated problems requiring data processing expertise to resolve. For example, it certainly would be unfortunate if a large paratransit agency acquired R:base with the intention of using it on floppy disks.

It is not our intention to single out the problems associated with using of R:base for this purpose. We believe it is an excellent product. We are simply most familiar with its strengths and weaknesses. We are quite certain that all of its competitors possess their own strengths and weaknesses. The points we wish to emphasize are:

1) the importance of conducting an extensive software search under the guidance of data processing professionals who can match the agency's need with the available products; and

2) the likelihood that even if the suggestion in 1) is followed, unanticipated problems will emerge requiring data processing expertise to resolve.

Acknowledgements

This paper is based on a study completed in July, 1984, by Dynatrend Incorporated with support from the Center for Transportation Studies for the Office of Methods and Support, Urban Mass Transportation Administration, U.S. Department of Transportation. The views expressed in this paper represent those of the authors.

Marc R. Cutler, Manager, Planning and Training Programs, Dynatrend Inc., Woburn, Mass.; Lawrence J. Harman, Director, Transportation Planning and Research, Massachusetts Executive Office of Transportation Boston, Mass. 02116.

COMPUTER SIMULATION MODELING: APPLICATIONS FOR TRANSPORTATION POLICY ANALYSIS

Barry L. Nazar and James E. Hayth

Introduction

The general topic of this presentation is the use of simulation modeling in the application of microcomputer technology to specialized transportation. The paper will begin by establishing a connection between these topics; describe where simulation modeling fits into the overall schema of microcomputer applications; and a case will be built for the merits of simulation modeling. The model building process will be described for one particular approach to simulation; i.e., system dynamics, by demonstrating some simple applications.

Microcomputer Technology

Microcomputer capability is rapidly coming to approximate everything that once was the sole domain of large mainframe computers. The existing differences between microcomputers and mainframe computers tend to be only a matter of size. Mainframes have larger disk storage capacity, larger processing capacity, and larger user networks. These differences are all relative and each year the gap becomes smaller. There is a level of computers which covers a midrange between micro and mainframe, i.e. the minicomputer. In a few years, the distinction between micro and mini will be practically nonexistent. A new denomination of computers, the personal computers and the home computers, is emerging, which covers the low end once held by microcomputers.

Looking at computers from a management information system (MIS) standpoint (Davis, 1974), suggests there are three general levels of application for computers: (a) Operational control, (b) Management control, and (c) Strategic planning. The relative uses of the computer verses roles of people are distinctly different fro each level of application.

(a) *Operational control*

The kind of applications which the computer can play the greatest role is in operational control. Once the programming has been developed, applications of this kind can be highly automatic applications in operational control include: scheduling, invoicing, mailing, metriculating, and any other kind of process that involves routine use of information.

A special variant of operations control is word processing. Word processing greatly increases the productivity of the routine task of typing. Word processing also exemplifies one of the advantages introduced by the microcomputer, namely, interactive transaction between user and computer. Prior to the advent of microcomputers, the field was dominated by mainframe applications. These applications tended to focus on bigness and efficiencies of scale. Tht general orientation on efficiencies of scale probably explains the prevalence of "batch mode" applications in the larger data processing departments. Batch mode applications usually involve a high volume of keypunch data entry followed by a large production of reports. In the batch mode operation, there is little opportunity for the users to interact with either the computer or their data.

The more recent emphasis on interactive processing in the computer field can be attributed to the microcomputer industry. In its efforts to find new markets, new users, new buyers, the industry has appealed to the more personal, the more specific, and the more flexible needs of individuals. The result is that computers in general, due to interactive type software, are adaptable to a wide variety of operational control functions. Line staff can use the computer to alleviate a great many mundane tasks; e.g., computing the number of days between two dates, or mileage from odometer readings.

(b) *Management control*

Applications in management control are qualitatively different from those of operational control. These applications include: hiring, firing, promoting, allocating resources, quality assurance, budgeting, evaluating, contract setting, etc. For management control, there is a greater degree of human judgement required and a wider range of contingencies to be considered. Applications in this area are far less subject to automation. Kotter (1982) suggests that managers spend very little time on control information and numerical data. He also suggests, however, that effective managers do have elaborate information networks, and a highly developed intuitive sense of their industry.

Despite Kotter's assessment, microcomputers do offer useful assistance for management control type applications. The first big breakthrough came with the development of "spreadsheet" type software, which offers great versatility in computation and examination of "what if" econometric scenarios. Now, a wide variety of management science software is available. A recent review of microcomputer software (Fawcette, 1984) compared 50 programs written for project management (or network analysis). One senior executive (Davis, 1984) noted after joining a company which made microcomputers readily available: "Until the last few years, I had viewed most of the more complex quantitative techniques that I learned at business school as so much spare baggage; I now find that I have used more of them in the last two years than I had in the previous ten." He noted furthermore, that the strategies developed on microcomputers yielded his company more than $2 million per year.

In summary, microcomputers offer useful instrumentation for management control applications. These kinds of applications, however, call for much greater human judgement, insight, and ability to formulate problems. The computer, in these cases, is a tool which can extend human skills. The computer cannot, however, substitute for human activity in the ways possible for operational control applications.

(c) *Strategic planning*

There is a level of analysis that considers the "big questions." These are the strategic planning applications. They include: the setting or adjusting of agency mission, the formation of major policies of operation, the response to environmental changes, and other activities toward preparing for the near and distant future.

Of the three levels of computer application, strategic planning calls most for a predominantly human input. The factors to be considered are value laden, highly circumstantial, and highly uncertain. Because of these factors, strategic planning is often neglected, or conducted poorly. The greatest difficulty in strategic planning lies with managing such unwieldy information, and doing so only within the bounds of human cognition. There is empirical evidence (Miller, 1956) that the human mind is capable of considering only "seven plus or minus two" simultaneously active variables.

For specialized transportation systems, however, strategic planning may be one of most important dimensions for ongoing success. Usually, these systems interface many other agencies, deal with a variety of special need populations, have a multiplicity of funding sources, and have disparate objectives, which are often conflicting as, for example, efficiency verses versatility. In short, special transportation systems are complex and have many contingent factors. A change in any given element of the system may produce reverberating consequences that affect the performance of the entire system.

Microcomputer technology has been slow to respond to these kinds of managerial needs. Some software tools are emerging, however, which do offer promise for enhancing our abilities in strategic planning. Most of these are various kinds of modeling tools; e.g., game theory, expected value computation, queuing, goal programming, and simulation modeling. This paper addresses the general utility of simulation modeling, particularly for strategic planning applications.

A Note on Organizations

Before jumping into the business of simulation modeling, it is useful to examine what it is that is being simulated, namely, organizations. In doing this, the role of simulation modeling can be examined in the overall schema of microcomputer applications.

Simon (1976, 1977) considered the question: "How can we understand organizations?" He concluded that the basis for understanding organizations is the Unit of Decision. Prior to any action there is a decision. Sometimes the decision immediately preceeds an action, and other times the decision occurred long before. In the latter case, Simon borrowed from the thinking of Barnard (1938), who offered the notion of Zone of Indifference, which is a range of actions where organization members act without question. In all cases, Simon asserts that an organization creates or fosters Decision Premises which provide the salient factors for decision making by its members. In large part, it is these decision premises which must be simulated. With simulation modeling, one can also examine the potential effects of changing decision premises: the "what if."

In preceeding sections, three levels of information processing applications were arbitrarily conceptualized: operational control, management control, and strategic planning. One qualitative difference among these has to do with the explicitness of the decision premises attending each. In operational control functions, for example, the connection between decision premises and action is very explicit. If such and such occurs, do this or that! Strategic planning activities have a broader set of premises (some originating from outside the organization) and their connection with action is just as potent, but the explicitness of the connection is less clear.

Simulation modeling can be applied to all three levels of information processing. Its greatest utility, however, is in developing an understanding among those premises, actions, and outcomes that are less clear. A well conceived simulation model will include those premises for operational control and management control in the context of a strategic objective.

Simulation Modeling

In the broadest sense, simulation models are any representation of reality. This could include painting, statues, photographs, and plastic handbags that look like real leather. Usually, though, the term is applied to dynamic "imitations" that behave like real phenomena. The earliest of these, and still very prevalent, are physical models; e.g., wind tunnels, miniature vehicles, etc. Slightly more abstract physical models include psychodrama and group dynamic exercises where people simulate situational realities. In the parlance of computer technology, simulation models are mathematical abstractions of reality.

In connection with computer simulation, there are a variety of approaches employed. Artificial intelligence is the simulation of human intelligence and problem solving which incorporates search, pattern recognition, inductive inference, and learning. Heuristic programming employs step by step procedures for finding satisfactory solutions by successively reducing the amount of search. A computer program which plays chess is an example of heuristic programming. Monte Carlo simulations involve random sampling of probability distributions which represent the elements and processes of real-life situations. System simulation which will be discussed further below, imitates the flow of goods, people, products, and information in large, complex systems. System simulation is the most versatile and generally applicable of the simulation approaches.

There are a number of system simulation languages, such as, SIMSCRIPT, GPSS, DYNAMO, and others. Many of these are oriented toward highly trained technicians or engineers. One exception is DYNAMO, which can readily be mastered by most generalists. DYNAMO is also of special interest for this discussion because a microcomputer version, MICRO-DYNAMO, is available for the Apple II and the IBM-PC (Pugh-Roberts Associates, 1982). For those who have other types of computer equipment, or where the CYNAMO language is not available, George Richardson (Roberts, et al., 1982b) the SYSDYN software package has been developed, which allows for writing simulation models in BASIC (included in the Instructor's Manual).

The DYNAMO language was developed by Alexander Pugh, III (1976) for a particular approach to system simulation known as System Dynamics. System dynamics began originally as Industrial Dynamics (Forrester, 1961) and then generalized to include Urban Dynamics (Forrester, 1969) and World Dynamics (Forrester 1973; Meadows et al., 1972). With these wider applications, the approach is generally known, now, as system dynamics.

System dynamics emphasizes the application of feedback control mechanisms in organizational, managerial, and socioeconomic problems. What made this approach possible was the pioneering efforts of certain "intellectual giants" of past and present, who translated servomechanism concepts from the engineering field into a more general scope. Weiner (1948), for example, refined and generalized the concepts of cybernetics (feedback control processes) to man and society. Tustin (1953) and Simon (1952) demonstrated applications in economic and business. The ultimate result of the advent of system dynamics and the DYNAMO language is that powerful conceptual tools, which were once only available to mathematicians and engineers, are now at the disposal of generalists.

System Dynamics

System dynamics, in addition to a methodology, offers something of a "philosophy" about systems as well (Roberts, 1978; Forrester, 1980). Forrester suggests that systems are a fundamental phenomenon of contemporary life. Much of our understanding of things, therefore, rests on our ability to comprehend systems. He notes: "We have been overwhelmed by fragments of knowledge but have had no way to structure this knowledge" (1980, p. 2).

Forrester defines a system as, ". . . a grouping of parts that operate together for a common purpose" (1980, p. 1). He suggests, further that there are two kinds of systems: open systems and feedback systems. Open systems are those that respond to inputs, but where the system output has no effect on the inputs.

Earlier, we noted Simon's view that the unit of decision is fundamental to understanding organizations and that decisions are made according to decision premises propagated in the organization. In the system dynamics approach, decisions are always connected to one or more feedback loops. These feedback loops are not always immediately evident, just as decision premises are not always immediately apparent. It is suggested, however, that these two constructs, feedback loops and decision premises, are the same stuff. In this sense as stated above, "It is the decision premises which must be simulated."

Model Building

The model building process in the system dynamics approach begins with a very general and flexible technique called causal loop diagramming. The next several steps in the process, flow diagramming and programming (with DYNAMO), add successively greater explicitness until the model is fully computerized. The output from the computer runs is used iteratively to refine, adjust, and expand the model. Finally, a sensitivity analysis should be conducted. Sensitivity analysis involves changing certain values or assumptions about variables in the model and testing what effects these variables have on the rest of the model. If the changes produce large effects, then one is aware of the accuracy required for certain assumptions. A sensitivity analysis also provides useful information about policy alternatives.

Causal Loop Diagramming

The first step is to define a problem and the most salient variables using as an example the problem of maintaining sufficient capital and fleet capacity over the next five years. The most immediate variables are: revenues, expenses, and capital.

The next step is to specify the relationships among these variables. In causal diagramming a relationship is given as either "direct" or "inverse." Revenues have a direct effect on capital. As revenues go up, capital goes up. Expenses, on the other hand, have an inverse effect on capital. As expenses go up, capital goes down. If expenses go down, however, capital goes up (assuming revenues continue coming in). The important thing about relationships is that inverse relationships do not necessarily decrease the affected variable, and direct relationships do not necessarily increase the afffected variable. The type of relationship merely specifies whether the affected variable goes up and down with the antecedant variable, or whether it behaves inversely to the antecedant variable.

The causal diagramming process continues by elaborating on those variables which need to be included in the model. In this example shown in Figure 1, revenues are directly affected by the amount of service delivery. And, the amount of service delivery is affected by a combination of demand and the paratransit capacity (i.e., number of operating vehicles). Capacity is affected by the purchase of new vehicles and the rate of depreciation. Depreciation, in turn, is affected by vehicle use, or the volume of service delivery. There are many additional variables which could and should be added to the model, but this is sufficient for our demonstration.

The final step in causal diagramming, shown in Figure 2, is identifying the feedback loops which emerge (e.g., capital—capacity—service delivery—capital) and then specifying thether a feedback loop is "positive" or "negative." Positive loops feed back on themselves in a manner which reinforces the initial effects. Positive loops tend to show exponential growth or decay. Negative loops, on the other hand, feed back on themselves in a manner which counteracts the initial action. they tend to oscillate. Depending on the loops connected with a negative loop, the oscillation may become "dampened" or "amplified." A quick way to determine whether a loop is positive or negative is to count the number of inverse relationships in the loop. If these add to zero or an even number, the loop is positive. If these add to an odd number, the loop is negative.

Flow Diagramming

A fundamental notion in system dynamics is that systems consist of levels and rates. Levels include anything in the system which accumulates or integrates over time. An intuitive way to think of levels is to imagine that the system is "frozen;" i.e., that nothing is moving. Whatever one sees at this point is probably a level. In this example, there are two levels, capital and capacity. Demand could also be a level, except that it has been assumed to remain constant throughout for simplicity. If the model were expanded it might also include drivers, equipment, morale, skills, etc. as levels.

Levels are only changed by rates. Rates indicate the flow of quantities into and out of levels. Rates also represent policies, decisions, and actions. Rates may be affected by levels and other information, but not by other rates. In our example, revenues and expenses are rates which affect the level of capital. This is also consistent with accounting theory which closes each period by posting the retained earnings or losses into one or more of the balance sheet accounts. Revenues and expenses reflect the rates of change and the balance sheet accounts reflect the accumulating levels of the system.

Information about levels, rates, and constants are indicated by auxiliary functions. Auxiliary functions show points where information about the system is processed in some way and used to influence other components in the system. In this example, an auxiliary function is used to determine the gap between capacity and demand. Another auxiliary is also used to determine the daily number of services delivered by taking the lower of capacity to deliver and demand for services.

The flow diagram of this model Figure 3 also uses constants: one for the service demand, and one for the number of trips each vehicle can deliver in a day, load. In the final program, some additional constants will be added for reasons explained below.

Finally, the example includes a delay function. A delay is a special kind of level and rate combination. As input flows into the delay, the output is deferred over a period of time intervals set by the model builder. In the example, vehicles are purchased (rate function) when the gap between demand and capacity reaches a critical difference and when there is also sufficient capital on hand to make the purchase. by putting new vehicles into the delay, the lag which occurs in getting the vehicle fully operational within the system (training a driver, etc.) is simulated. To appreciate what is accomplished by flow diagramming, one should study the flow diagram before proceeding to the next section.

Programming and Running the Model

A fully description of programming in DYNAMO is beyond the intended treatment of this presentation. One should notice in the attached program listing, however, that the programs are relatively short compared to what would be required in other languages such as BASIC, FoRTRAN, CoBOL, PASCAL, etc. The programming requires only an elementary understanding of algebra.

Each equation in the model, shown in Figure 4, is preceded by a letter which indicates the type of equatin being used. "N" indicates an iNitial value of a level. "L" indicates a Level equation. "A" indicates an Auxiliary

Figure 1

ELEMENTS of CAUSAL DIAGRAMS

Variables

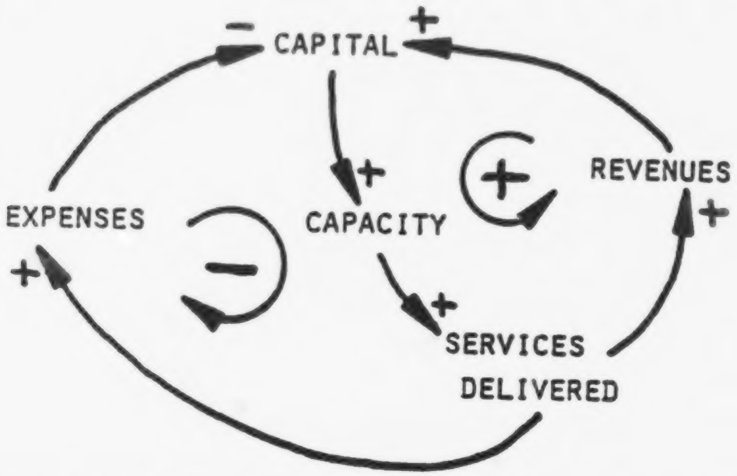
CAPITAL, EXPENSES, REVENUES, CAPACITY, SERVICES DELIVERED

Relationships

$\text{REVENUES} \xrightarrow{+} \text{CAPITAL}$

$\text{EXPENSES} \xrightarrow{-} \text{CAPITAL}$

Feedback Loops



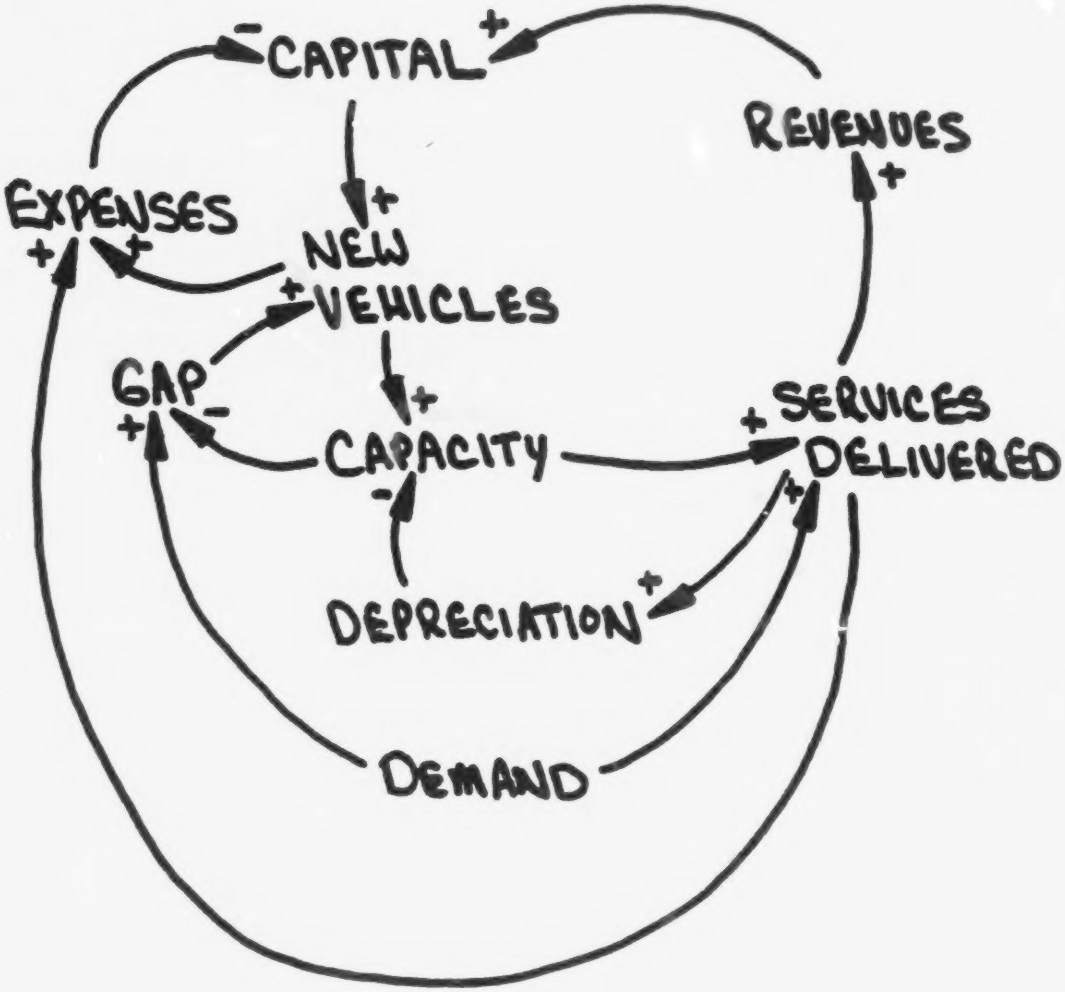
LEGEND Causal loop diagrams consist of variables, relationships, and feedback loops. Variables include, at the outset, those most immediately connected with a problem or topic of interest.

Relationships among variables are depicted with arrows. The arrows show the direction of the relationship (tail to head) and the type of relationship. Relationships can be "direct" or "inverse." The "plus" sign over the arrow head indicates a direct relationship, and a "minus" sign indicates an inverse relationship.

Feedback loops occur when a sequence of relationships among variables shows a circular connection to an earlier part of the chain. Feedback loops may be "positive" or "negative" depending on the types of relationships in the sequence. A rule of thumb is, whenever the number of "minus" signs adds to an odd number, the loop is negative. Whenever the minus signs add to zero or an even number, the loop is positive. Positive and negative loops produce very different patterns of behavior.

Figure 2

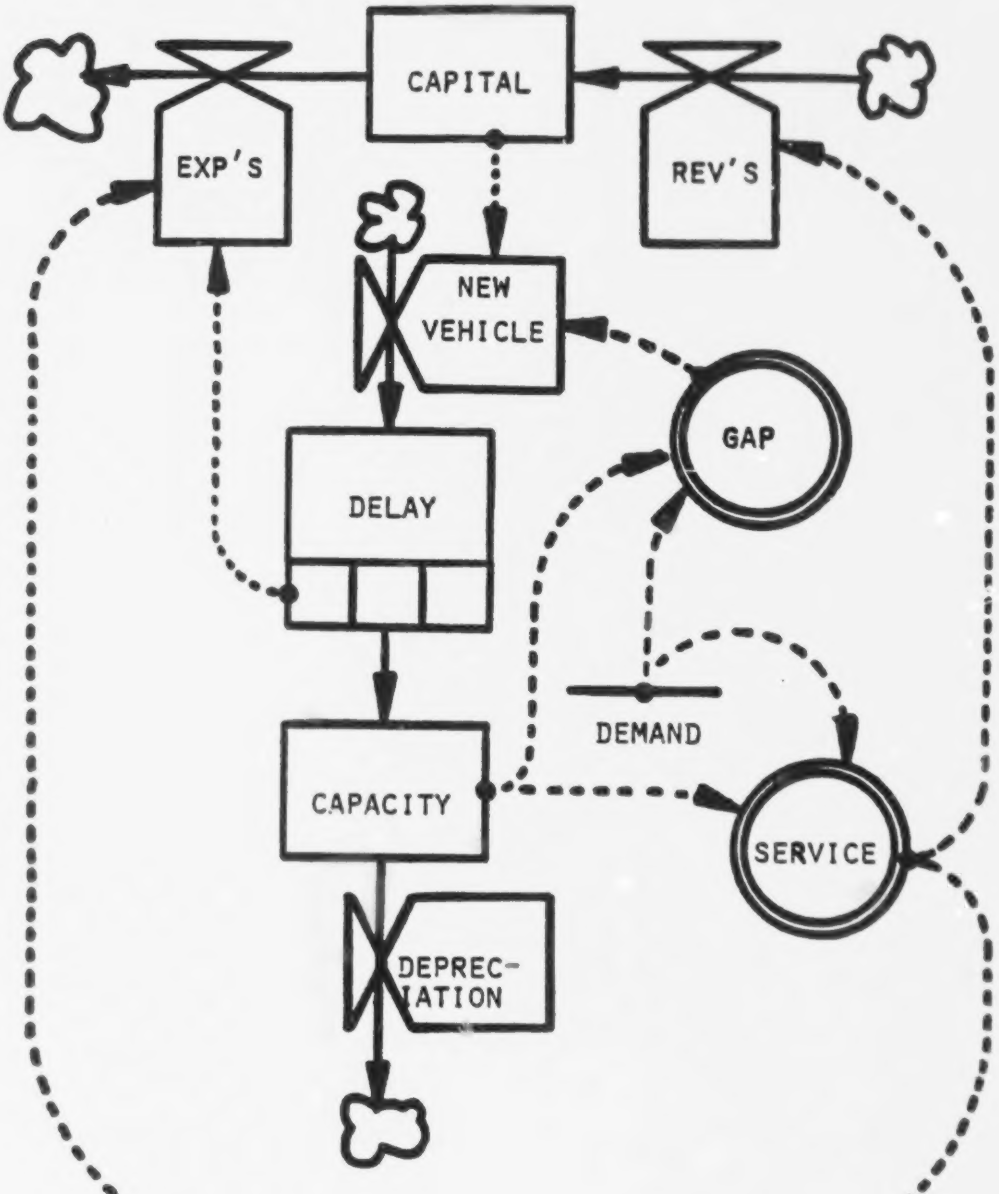
CAUSAL DIAGRAM -- Expanded



LEGEND This diagram continues from the preceeding causal diagram by identifying additional variables needed to explain the system's dynamics. For example, capitol doesn't automatically lead to increased capacity. It only does so by purchasing "new vehicles." And, the system manager does not automatically buy new vehicles just because he has the capitol. He only does so when there exists a "gap" between "capacity" and "demand." In addition, capacity (fleet size) doesn't endure forever because vehicles are subject to "depreciation." "Depreciation" is also affected by the amount of use; i.e., "services delivered." How many feedback loops are there now?

Figure 3

FLOW DIAGRAM -- Example



equation. "C" indicates a Constant. "SPEC" indicates SPECifications for time intervals and computer output.

In the equations, one will see a "." followed by the letters "J" "K" and "L". These are subscripts which denotes time intervals. "K" is the present time. "J" is the previous interval. "L" is the next future interval. The model operates by computing stepwise from "J" to "K" to "L". As the model moves to time interval "L", it bootstraps its way to the next interval so that "L" becomes "K"; i.e., the present interval, and all calculations are repeated again. DYNAMO does this repeatedly until the specified number of time intervals have been completed. There may be a few, or hundreds depending on the model builder.

Ten of the equations in the model are constants. The flow diagram does not require all of these, but there is a particular advantage to using constant variables in the arguments of the other functions. DYNAMO allows for reruns of the model as many times as desired. At the outset of each rerun, one has the option to change temporarily any variable specified as a constant. In the example, the cost of a new vehicle, VEH, was set to $15,000. On a rerun this could be changed to some other price. The rerun capability of DYNAMO makes it convenient to test policies and to conduct the sensitivity analysis recommended above.

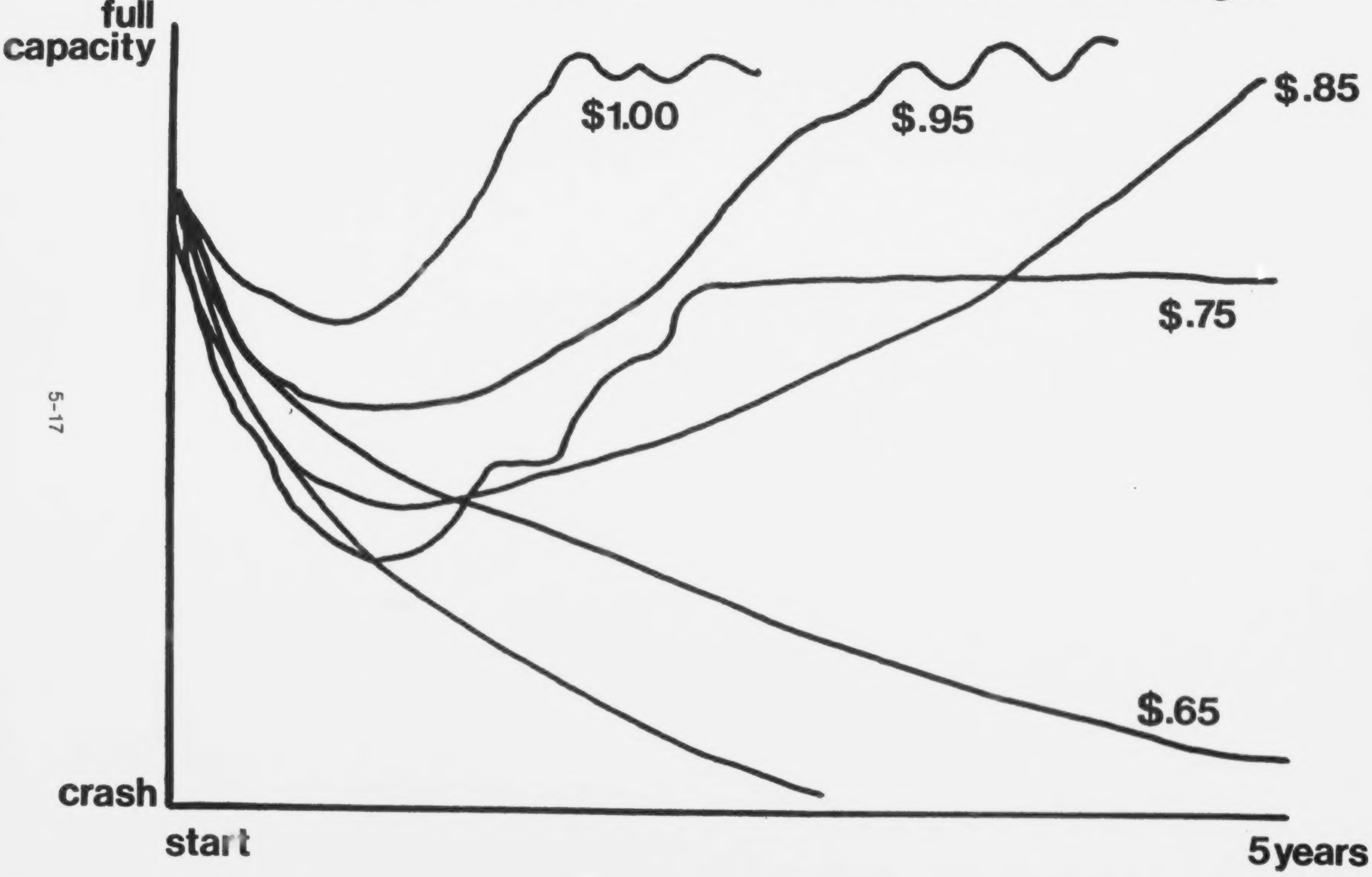
The output from DYNAMO is available in two forms: (a) tabular listings of specified variables, and (b) graphic

Figure 4. Model Equations

*	**Transit Model**	
Note		
N	CAP = 5000	CAP = Capital (starting ' $5,000)
N	CAPC = 25	CAPC = Vehicles (starting ' 25)
L	CAP.K = CAP.J'(DT)(REV.JK-EP.JK)	Level Equation for Capital
L	CAPC.K = CAPC.J'(DT)(PUR.JK-DEP.JK)	Level Equation for Capacity
R	REV.KL = (SERV.K)(FARE)	REV = Revenue (Services X Fares)
C	FARE = 5	FARE = Revenue from each Service
R	EP.KL = COST*SERV.K'(MIN(NEWA.K, NEWB.K)*veh)	EP—Expenses (Cost X Trips plus Vehicles)
C	COST = 3.5	COST = Operating Cost per Trip
A	SERV.K = MIN((CAPC.K)(LOAD),DEM)	SERV = Services (lesster of CAP or Demand)
C	LOAD = 70	LOAD = Capacity of one vehicle per day
C	DEM = 2000	DEM = Demand for Services
A	GA.K = DEM-(CAPC.K*LOAD)	GAP = Gap between Demand & Capacity
R	PUR.KL = DELAY1(NEW.JK,LAG)	PUR = delayed purchase into fleet
C	LAF = 60	LAG = Time factor for delay
R	DEP.KL = (SERV.K)(MILES)/100000	DEP = Depareciation (day's mileage/100,000) 100,000 is lifetime of a vehicle
C	MILES = 5	MILES + Average miles per trip
R	NEW.KL = MIN(NEWA.K,NEWB.K)	NEW = 1 for purchase, 0 for no purchase
A	NEWA.K = FIFGE(1,0,CAP.K,VEH)	NEWA = 1 if there's capital for buying
C	VEH = 15000	VEH = price of a new vehicle
A	NEWB.K = FIFGE(1,0,GAP.K,LOAD)	NEWB = 1 if GAP greater than LOAD
SPEC	DT = 1	DT = simulation time interval, 1 day
C	PLTPER = 30	PLTPER = time intervals for plotting
C	PRTPER = 30	PRTPER = time intervals for printing
C	LENGTH = 1725	LENGTH = number of intervals to simulate 1725 days = 5 years.
	PLOT CAPC = C/CAP=$/SERV = S	Variables to plot
	OPT BW	OPT = options for screen & plotting
	RUN	

Figure 5

Simulated Capacity Growth for Different Profit Margins



plots of specified variables. The Micro-DYNAMO version also renders high resolution color graphic plots.

Sensitivity Analysis

A number of runs were conducted on the model demonstrated here. Two variables show particularly strong effects on the behavior of the system; viz., FARES and COST. FARES is the revenue generated from each trip delivered. COST is the estimated operating or unit cost for delivering a trip. Actually, it is the difference between these variables which produces the strong effects; i.e., the profit margin per trip delivered.

With the variables set as specified in the program listing, the system starts out with too few vehicles to meet the full demand for service; i.e., 2,000 trips per day. The system, therefore, needs to build its capacity to meet this demand. If the profit margin is below $.75 per trip as shown in Figure 5, the system declines exponentially over a five year period and finally collapses completely. The lower the profit margin, the more rapid is the decline and the earlier is the collapse.

If the profit margin is at least $.80 per trip, then it grows exponentially in its capacity, its service delivery, and its accumulated capital. The greater the profit margin, the more rapidly this growth occurs. At a profit margin of $.80 per trip, it takes five years to approximately meet the service demand. At $1.00 or more, capacity maximizes within the first two years. Regardless of how high the profit margin is, however, the system never maintains delivery at 100 percent of the demand. This is because the model assumes that new vehicles will not be purchased unless there is a critical gap between demand and capacity. As vehicles continually depreciate, the capacity continually sides slightly below the demand.

If the profit margin is set at $.75, the system declines to a capacity which meets about 70 percent of the demand and then levels off with no further changes in capacity or service delivery. In this scenario, capital oscillates between zero and the price of a new vehicle ($15,000). The phenomenon resembles something like a "breakeven point."

Conclusions

Although this demonstration offers an over simplified case example, it conveys the kinds of things that can be done with the system dynamics approach to simulation modeling. The intent of this presentation is to show where simulation modeling fits into the overall schema of computer applications. It also attempts to demonstrate what is involved in building simulation models and suggest the kinds of applications that may obtain from its use.

References

Barnard, C. I. The functions of the executive. Cambridge, MA: Harvard University Press, 1938.

Davis, D. Computers and top management. Sloan Management Review, 25(3), 63-67, 1984.

Davis, G. B. Management information systems: conceptual foundations, structures, and development. New York: McGraw-Hill, 1974.

Fawcette, J. E. Choosing project management software. Personal computing, 154-167, October 1984.

Forrester, J. W. Industrial dynamics. Cambridge, MA: MIT Press, 1961.

Forrester, J. W. Urban dynamics. Cambridge, MA: MIT Press, 1969.

Forrester, J. W. World dynamics. Cambridge, MA: MIT Press, 1973.

Forrester, J. W. Principles of systems (2nd ed.). Cambridge, MA & London: MIT Press, 1980.

Kotter, J. P. What effective managers really do. Harvard Business Review, 156-167, November-December 1982.

Lyneis, J. M. Corporate planning and policy design. Cambridge, MA: The MIT Press, 1980.

Meadows, D. H., Meadows, d. L., Randers, J., & Behrens, III, W. W. The limits to growth. New York: Universe Books, 1972.

Miller, G. The magic number seven plus or minus two. The Psychological Review, 1956.

Pugh-Roberts Associates. Micro-dynamo system dynamics modeling language. (Computer program). Reading, MA: Addison-Wesley Pub. Co., 1982.

Roberts, E. B. System dynamics: an introduction. In E. B. Roberts (Ed.). Managerial applications of system dynamics. Cambridge, MA: The MIT Press, 1978.

Simon, H. A. Administrative behavior (3rd ed.). New York: The Free Press, 1976.

Simon, H. A. The new science of management decision (rev. ed.). Englewood Cliffs, NJ: Prentice-Hall, 1977.

Barry L. Nazar, Deputy Director for Program Development, and James E. Hayth, Director of Transportation, Dauphin County, Harrisburg Pennsylvania, 17101.

AN INTRODUCTION TO UTILIZATION OF MICROCOMPUTERS BY SPECIALIZED TRANSPORTATION PROVIDERS

Robert E. Paaswell, Claire E. McKnight and Joseph V. Depa

Focus of Paper

Much has been written about the ability of the microcomputer to increase the productivity and efficiency of a transportation organization. There is little question that many of these claims are true. Underlying these claims, there is a wide range of computing power available through microcomputers and an extremely wide range of applications, using commercially available software programs and customer designed software.

The purpose of this paper is to discuss the utilization of a specific range of microcomputers and software. This range is potentially of greatest interest to users, because it is the easiest to obtain and to set up in the office, and it has software that is widely used and, hence, easy to learn and utlize In short, the microcomputers and software we will discuss are becoming known as industry standards. While there are many special services providers who use sophisticated software/hardware, perhaps the majority of providers do not yet use microcomputers. This paper is directed towards the non-user or the provider still making decisions concerning microcomputer acquisition.

Computer Basics

Hardware: There are over one hundred brands of basic microcomputers (computer, screen and disk drives) and if additional peripherals of various kinds are added (printers, modems), literally thousands of perplexing components are available from which to select a system.

The most widely used system is an IBM-PC compatible system, that is, one that can utilize the Microsoft DOS operating system, and software written for that system. In order for a special services provider to utilize, with adequate capacity, the available sophisticated and integrated software, the microcomputer should have at least 320 kilobytes of Random Access Memory (320K RAM). The microprocessor should be a 16 bit microprocessor. The computer should have two disk drives with capabilities of storing 320 k per disk, or one disk drive and one hard disk, that being a fixed storage system capable of storing more than 1 million bytes of information. A monochrome monitor is adequate. The choice of printers, letter quality, or high quality dot matrix, is determined by the quality of output needed.

Software: There are three major categories of off-the-shelf software that are of greatest use to special services transportation providers. These are wordprocessors, spreadsheets and data-base managers. The newest software packages integrate these capabilities (e.g., Lotus Symphony), and may be adequate for much of the daily work done by a provider. More detailed programs can still be obtained for wordprocessing (e.g., Wordstar) and data base management (e.g., dBII) than currently is available in integrated packages. A survey of activities conducted by typical special services providers together with the types of software that would be appropriate for such tasks is summarized in Figure 1.

Program Utilization

An example of software use is shown in Figures 2a and 2b which show components of a small provider's budget process. The software, (Lotus 1-2-3 was used for this example), makes possible the combining aspects of a database management system with a spreadsheet. The following points underly the value of the computer in this instance:

> The format of the budget, and the data put into the budget is constructed by the provider. There is no need to change familiar or required procedures.
>
> The microcomputer can serve as a file manager. Data entered into different files (costs, receipts, daily logs) can be retrieved from and integrated into other files. With careful utilization of the software, once a number is entered into a file, it does not have to be reentered. This eliminates the time consuming, (and often error prone), procedure of copying data from files for analysis.
>
> The microcomputer can assist in forecasting as well as budgeting and helping to establish strategies for "what if" situations. Through features such as worksheet recalculation, as data inputs change, so do output data.

In Figure 2.a, the data has been set-up in a data base format. For the example shown, Lotus 1-2-3 is the software used. It provides a low level of data base management and is tied to the format of the spreadsheet. For

Figure 1

	S	D	P	WP	G
Vehicle Maintence (Daily, Weekly, etc.)					
Procedures		X		X	
Frequency of Reparis	X	X			
Time Management	X	X	X		
Material/Labor Costs (Individual or Group)	X	X			
Inventory		X			
Preventative Maintenance Scheduling		X			
Determine if Leasing is Proportional to Quality/Cost of Maintenance	X	X			
Vehicle Maintenance Records	X	X			
Vehicle Cost History	X	X			
Computer Assisted Dispatching (Optimization)					
Graphics Depicting Periodic Changes	X				X
Record Files (current addresses, regular destinations, etc.)		X			
Reservations 2 Types					
• Regular Trips		X			
• Ad-hoc (advance notice)		X			
Daily, Separate Scheduling		X			
Increase in Rider Participation due to Requests/Dispatching	X	X			
Indentification of Hybrid Options or Services					
• Route Deviation	X				
• Point Deviation	X				
• Check Points	X				
• Cycled Service	X				
• Special Social Functions (Major Activities/Destinations)	X			X	X
• Integration of Demand-Responsive Link Between Activity/Destination and Dispatcher (i.e. updating)	X	X			X
• Trip Lengths	X	X			
Determination of Vehicle Type	X	X			
Determination of Service Zones and Characteristics	X	X			
• Transfers	X	X			
• Service Hours	X	X			
• Fare Policy	X	X			
Consolidation of Vehicles and Schedules	X			X	
Office Assistance					
Inventory of Office Equipment, Supplies, etc.	X	X		X	

	S	D	P	WP	G
Individual (client) Records—"Categories"					
• Name, Address, Phone		X			
• Regular Destination, Time, Frequency		X			
• Personal Inforation: Emergency person and phone, allergies, doctor, handicap		X			
Computer Assisted Labeling, Mailing		X		X	
Bookkeeping, Auditting, Budgetting	X	X			
Clerical					
• Reports w/Trip Records	X			X	
• Registration Data				X	
• Summary Information File		X		X	
• Key Search		X			
• Master Reports (mileage and trip totals, revenue/expenditure data)	X	X		X	
• Accounts Payable/Receivable	X	X			
Miscellaneous					
Scheduling Annual or Semi-Annual Driver Training Classes Seminars, Re-Licensing, First-Aid and Live Saving Techniques (CPR)	X			X	
Surveys (demographic and others)					
• Questionaire Creation/Tabulation	X			X	
• Spreadsheeting of Data, Statistics	X				
• Graphical Representation	X				X
Graphics of Vehicle Maintenance, Revenue/Costs (past, present, future), Ridership	X				X
Quantifying Compliants by driver and plaintif—time, nature of complait	X	X		X	
Productivity Ratings					
Marketing Strategies					
• Fund Raisers				X	X
• Advertising (ideas, costs)				X	X
• Advertising Requirements, Mediums				X	X
Operations					
• Risk Management	X				
• Single Billing System (arrangement of fare structures helps with subsidizing)	X	X			

S: Spreadsheet; D: Data Base Mangr.; P: Project Mangr.;
WP: Word Processor; G: Graphics

Figure 2a

Special Services Transportation Example of Data Base Management

Billing Records

Bills Paid

Date	*Vendor*	*Amount*	*Code*
01-Jun-83	X Oil Co.	$ 325.00	G
01-Jun-83	Ill. Telephone	550.00	U
01-Jun-83	State unemployement	265.00	O
01-Jun-83	Kogul Real Estate	1,150.00	O
01-Jun-83	Aone Accounting	150.00	O
08-Jun-83	Ill. Gas Co.	400.00	O
08-Jun-83	X Oil Co.	378.00	
08-Jun-83	Spark Radio Repair	65.00	M
15-Jun-83	Ill. Elecric Co.	690.00	O
15-Jun-83	X Oil Co.	346.00	G
15-Jun-83	City Insurance	1,200.00	O
15-Jun-83	Good Auto Repair	450.00	M
15-Jun-83	Auto Supply Co.	54.00	M
	Total	**$6,023.00**	

Vender	*Amount*	*Code*
State Unemployment	$ 265.00	O
Mogul Real Estate	1,150.00	O
Aone Accounting	150.00	O
Ill. Gas Co.	400.00	O
Ill. Electric Co.	690.00	
City Insurance	1,200.00	
Total	**$3,855.00**	

Monthly Budget

		Function		
	Amount	*Overhead*	*Operations*	*Maintenance*
Salaries and Wages				
Operating Expenses				
Depreciation				
Maintenance				
Repairs				
Supplies				
Radio				
Other				
Overhead	$3,855			

Selection Criteria

Vender	*Amount*	*Code*
		O

simple tasks, such as the one shown, such a format is not only adequate, but it simplifies utilizing the data in the overall spreadsheet. It is important to reiterate. The microcomputer acts as a single point of entry, (file-cabinet). Once the data is entered it does not have to be reentered. In addition, some software programs permit transferability. In this case we might also have used a dedicated data base management software program, (e.g., dBII or Condor), and transferred files, using a few simple commands to the Lotus 1-2-3 spreadsheet.

For the first time user, it should be noted that programming skills are not needed! The steps in utilizing software are straightforward. Put the program disk in the computer, select the specific task one wishes to undertake and then enter data.

It is important to indicate that there is a learning period for most users of software. First, most software programs are quite literal. For example, when entering numbers you must differentiate between numbers as numbers and numbers as labels. But the literalness makes possible a great depth of formatting and analytic capability with the data one has.

Note that programs cannot be learned in 30 minutes, or during one tutorial. They are small languages in themselves albeit simple, and with a rigorous structure. A program with the depth of Lotus 1-2-3 will take four to six weeks of on-the-job use before its finer points are assimilated; in its simpler form, it can be used by the service after a few hours. The addition of a microcomputer then implies real time in an agency for learning. But the later productivity more than compensates for the invested time.

To return to the example, Figure 2a shows billing records entered as a data base. The record includes date, vendor name, bill account and a budget code (for example 0 = overhead). The data from the data base can be entered independently, or may have been transferred from original invoices recorded in a master accounting file. Note again, the data files can be transferred through the computer and do not have to be manually reentered at each point.

A data base program makes possible organization of data in any format one chooses, selection of specific data records, creation of new data files from existing files and the printing of inputs illustrating data in the format you select. In the very simple example of Figure 2a, we illustrate these features as used to allocate bills to particular cost functions. The computer creates a new file based on a selection criterion (shown to right of billing records) entered by the programmer. In this example, the criterion is overhead ("0") and the new file is shown immediately below the billing records. The computer then totals the entries in this file and transfers that total ($3,855) to a third file, which when finished, will show the monthly

Figure 2b

Special Services Transportation Example of Budgeting Strategies

	1984 Estimated Budget					*Fare Schedule*		
	1983 Budget	*Multiplier*	*Amount*	*Budget-Subsidy*	*Riders*	*Fare*	*Subsidy*	*+ L10*
Salaries and Wages	$40,000	110%	$44,000	$35,890	32000	$1.12	$195,000	$1.28
Benefits	6,000	100	6,000				185,000	1.59
Operating Expenses								
Depreciation	25,000	100	25,00			175,000	1.90	
Loan Service	6,000	100	6,000			170,000	2.06	
Maintenance	33,000	115	37,950					
Gasoline and Oil	26,000	113	29,380					
Supplies	3,300	110	3,630					
Radios	2,100	125	2,625					
Overhead	70,700	115	81,305					
Total	**$212,100**		**$235,890**					
State, Local Contributions	$212,000		$200,000					

Figure 2c

Special Services Transportation Example of Billing

List of Eligible Users

Name	*First*	*Address*	*Disability*	*Birth*	*Date*	*Telephone*	*Eligibility*	*Query*
Smith	Ann	132 Main	None		1921	334-6456	T, N, PA	Medical purposes?
Jones	George	13 Jackson, Apt.3b	WC		1929	334-9540	T, PA	Medical puroses?
Doe	Jane	39 Green Ave	Walker		1919	334-1988	T, A	
Johnson	Dick	75 Coal Ave	Cane		1914	655-3478	T, A, N	
Monroe	Jeff	193 Apple Road	WC		1962	344-9345	SW, PA	Workshop or medical?
Schmitt	Robert	450 North 13th	None		1916	655-8561	T, A, N	
Woodard	Marian	25 Oak	Non-Steps		1923	655-8111	T, PA	Medical purposes?
Coleman	Chris	133 Park	None		1953	344-1342	SW	Workshop?

expenses by function. Budget statements can be set up so that any changes in the input amounts can be adjusted as they are entered in other files, using a few simple spreadsheet commands. Thus, it is possible to enter data as often as desired and have up to the minute records of expenditures by category and total budget. Once the original data forms are established, and the relationships between the forms and individual data points set, all that need be done is enter data. Comprehensive spreadsheets (such as Lotus 1-2-3, Supercalc) also make it possible to lock in the format and commands, so that others in the agency can enter data, without disturbing the overall structure. This will be illustrated further in the next two examples.

Figure 2b carries the budgeting process a step further. Here, last year's (1983) budget is shown. The 1984 budget must be estimated. It is known that multipliers can be applied to each of the budget items (e.g., salaries for 1984 are 10 percent higher than for 1983). In the spreadsheet shown, multipliers were set for each of the budget categories. The 1984 amount was calculated as the (multiplier) X (1983 budget amount). This calculation was carried out for salaries and wages, and the spreadsheet, through two simple commands, repeated the calculation for the remainder of the budget items.

Note that, while in 1983, the budget was offset by public funding, such funding would be short in 1984. Could fares be collected to offset the difference? A range of possible subsidies is possible. Assuming, (as in 1983), there were 32,000 riders, a table was calculated indicating the fare needed to meet the budget shortfall. A "what-if" table was constructed that said:

* Given (Budget—Subsidy) = X_1

* Fare = X_1 / 32,000

(Both statements were constructed siply by identifying locations on the spreadsheets that gave input values to these equations). On the spreadsheet used (Lotus 1-2-3) a data table was established that automatically calculated fares for each subsidy value. The time it took to construct this table was literally a few seconds more than the time necessary to enter the subsidy amounts. This illustrates the very important productivity component of the microcomputer—the ability to evaluate more alternative courses of action in more detail than time previously permitted. This feature, coupled with the prodding to organize the variety of data and information available, is, we believe, one of the most useful, and one of the most productive features of the microcomputer. And, until an agency makes use of the micro, this feature will remain one of the most unknown and unappreciated features.

Our final example, Figures 2c, 2d, shows how record keeping can be automated and simplified and can lead to better files for billing or evaluation. Figure 2c is a partial client list. A number of clients are listed, with their transportation needs delineated. The agency gets funding from a variety of subsidy programs, which have differing criteria for eligibility. The programs each client is eligible for are given as codes under eligibility (Figure 2c). The reservation taker, sitting at the micro, records requests for trips using a spreadsheet that has been preprogrammed to make sure he gets all the information needed for billing (Figure 2d). In this case, the feature of the "macro" in Lotus 1-2-3 is used. A set of commands is grouped together and given a simple command name. We have called one command simply E (for eligibility).

When a telephone reservation comes in the following steps are taken:

1. The reservation taker (RT) takes down the callers name, origin, destination and time of trip on the log started for the day (Figure 2d, Step 1).

2. The RT then performs the following microcomputer operations:

   a. While the RT is still on phone, he enters the code "E" on the computer keyboard

   b. The computer asks for the range name (which will be the caller's name)

   c. The RT types the last name of the caller and enters it.

   d. The computer then probes for the file name.

   e. The RT types "L" and enters it.

   f. The computer displays programs the caller is eligible for and any questions the RT should ask the caller.

3. RT types in a code to indicate answer to query or type of trip. Box in No. 3. The computer erases the questions but keeps the eligibility codes and the answer. The agency then has a record that allows the bookkeeper easily to determine which accounts the trip might be changed to. The microcomputer can also sort the log by trip time for easier dispatching.

Figure 2d

Special Services Transportation Example of Billing

Step 1. Enter name of caller, origin, destination, and time.

Schedule

Caller	*Origin*	*Destination*	*Time*	*AP*	*Code*	*Elig.*
Smith	*134 Main*	*General Hospital*	*3:00*	*P*	*M*	*T,N,PA*
Smith	*Gen. Hosp.*	*134 Main*	*4:30*	*P*		
Schmitt	*Jack's Hardware*	*55 Polk*	*10.15*	*A*	*P*	*T,A,N*
Monroe	*193 Apple Rd.*	*14 Downers St.*	*9:30*	*A*	*M*	*SW,PA*
Monroe	*14 Downers St.*	*193 Apple Rd.*	*10:30*	*A*	*M*	
Jones	*13 Jackson*	*195 Green St.*	*10:30*	*A*		
Jones	195 Green	13 Jackson	4:30	P		

Step 2. a. Press command name E.
b. Enter caller's name.
c. When prompted, ask question.

Schedule

Caller	*Origin*	*Destination*	*Time*	*AP*	*Code*	*Elig.*
Smith	*134 Main*	*General Hospital*	*3:00*	*P*	*M*	*T,N,PA*
Smith	*Gen. Hosp.*	*134 Main*	*4:30*	*P*		
Schmitt	*Jack's Hardware*	*55 Polk*	*10.15*	*A*	*P*	*T,A,N*
Monroe	*193 Apple Rd.*	*14 Downers St.*	*9:30*	*A*	*M*	*SW,PA*
Monroe	*14 Downers St.*	*193 Apple Rd.*	*10:30*	*A*	*M*	
Jones	*13 Jackson*	*195 Green St.*	*10:30*	*A*		*T,PA**
Jones	195 Green	13 Jackson	4:30	P		

* Medical Purposes?

Step 3. Enter code for trip purpose in response to caller's answer.
NM = non medical trip.

Schedule

Caller	*Origin*	*Destination*	*Time*	*AP*	*Code*	*Elig.*
Smith	*134 Main*	*General Hospital*	*3:00*	*P*	*M*	*T,N,PA*
Smith	*Gen. Hosp.*	*134 Main*	*4:30*	*P*		
Schmitt	*Jack's Hardware*	*55 Polk*	*10.15*	*A*	*P*	*T,A,N*
Monroe	*193 Apple Rd.*	*14 Downers St.*	*9:30*	*A*	*M*	*SW,PA*
Monroe	*14 Downers St.*	*193 Apple Rd.*	*10:30*	*A*	*M*	
Jones	*13 Jackson*	*195 Green St.*	*10:30*	*A*	*NM*	*T,PA*
Jones	195 Green	13 Jackson	4:30	P		

This data can be translated to a billing sheet similar to that shown in example 2a.

Microcomputer Utilization

The above examples show how varius aspects of data and record keeping can be simplified using a microcomputer. The variety of tasks (noted on Figure 1) pertain to activities that occur over a range of provider types, as evidenced in the literature.

Review of case studies (McKnight, et al., 1982) on special services indicates many other areas where a microcomputer can assist 1) developing a single billing system; integrating different types of reservations (e.g. regularly scheduled trips, ad-hoc reservations); 2) developing and implementing marketing strategies and advertising; and 3) keeping maintenance records and cost histories. In addition to assisting in problem solving, microcomputers can be of help in many of the non-problematic areas of every day operations such as graphics, identification of service options, and client mailing data.

With the microcomputer appearing to be such an important organizational and productivity tool, will it find almost universal use by provider agencies? To answer that question, we surveyed twenty-one special service transportation agencies in the Northern Illinois area. Table 1 lists the agencies by size.

TABLE 1

Summary of Special Service Transportation Agencies Surveyed.

No. of Providers	*No. of Vehilces*	*No. of Employees*
2	1	2
2	1	3
1	1	5
1	1	7
1	2	3
1	2	4
1	2	7
1	2	10
1	3	3
1	4	5
1	4	8
1	5	8
1	5	11
1	8	12
1	9	14
1	11	16
1	32	16
1	50	64

A questionnaire was developed to ask the private paratransit operators questions concerning use or non-use of microcomputers. The survey (summarized in Figure 3) was designed to determine:

Quantity of microcomputers in use by the providers;

Operating environment (e.g. RAM, number of disk; drives, printers)

Incorporated uses and software used;

Reasons for not using a microcomputer.

Survey results were compiled and sorted on a microcomputer spread-sheet (Lotus 1-2-3). Sorting was done according to the number of vehicles (i.e., 1-4, 5 or more). Of those surveyed, two thirds had less than four (4) vehicles. Of the twenty-one users, only 19 percent (4) used microcomputers, the survey also indicated:

1. Of the fourteen operators with four or fewer vehicles, only one used a microcomputer. Of the seven operators with more than five vehicles, three used a microcomputer.

2. Everyone using a microcomputer had a printer.

3. The most common uses were wordprocessing, budgeting, and recording maintenance functions.

4. Everyone using a microcomputer anticipated the purchase of at least one more.

5. Of those who did not use a microcomputer, fourteen indicated no immediate future purchase. The reasons include:

- cost (5)
- not needed (4)
- couldn't help (3)

Discussion with the providers indicated that users found they could quickly apply the microcomputer to a variety of applications and even felt the need for additional microcomputer capability. The non-users had no appreciation of, or knowledge of, the variety of capabilities a microcomputer provides.

In summary, microcomputers can become an extremely important productivity tool for special services transportation providers. A few of the more readily apparent applications were illustrated. There is still a big knowledge gap between users and non-users; perhaps this will lessen as information concerning microcomputers becomes increasingly available.

Bibliography

Roberta Donsbach (1982), "The Application of Microcomputer Dispatch in a Specialized Transportation System Servicing the Rural Elderly." Specialized Transportation Planning and Practice, Volume 1, Number 2 (1982), pg. 137-141.

C. McKnight, A. M. Pagano, L. Robins, "A Coordination of Paratransit: Case Studies of Special Transpor-

Figure 3

Telephone Questionnaire

Number of Vehicles:

Number of Employees:

1a. **Do you use a Microcomputer?**
  Make & Model
b. Ram
c. How many disk drives?
d. Hard disk?
e. Do you have a Printer?
f. Type
g. Does your Printer have Graphics Capability?
h. Do you use a Modem?
i. Who are you connected with?

2. **Microcomputer Uses:**
  Word Processing
  Payroll
  Budgeeting
  Scheduling
  Accounts Payable/Received
  Client Records
  Maintenance Records
  Dispatching
  Other

3. **Available Software**

Functions:
Word Processing
Spreadsheeting
Database Manager
Project Manager

Assorted Packages:

4. **Do you do you own Programming in Basic?**

5a. **Do you anticipate buying another Microcomputer?**

b. For what purpose?

6a. *(NO:)* **Are you considering the purchase of a Micro computer in the future?**

b. *(Yes:)* **Do you plan to use it for:**
  Word Processing
  Payroll
  Budgetting
  Scheduling
  Accounts Payable/Received
  Client Records
  Maintenance Records
  Dispatching
  Other

c. *(No: Why Not:)*
  Cost
  In Future Plans
  Feels it is not as effiecient as present system
  Not convinced it could help
  "Not needed"

tation Agencies." Urban Transportation Center, University of Illinois at Chicago Circle, P. 0. Box 4348, Chicago, Illinois, 60680, Feb. 1982.

Multisystems of Cambridge, Mass. (1982), "A Report in the Series Paratransit: Options for the Future." General Community Paratransit Services in Urban Areas, DOT-1-82-15.

Multisystems, Inc. of Cambridge, Mass. (1982), "A Report in the Series Paratransit: Options for the Future," Paratransit Services for the Transportation Handicapped, DOT-1-82-18.

S. Rosenbloom, et al. (1981), "Cost Analysis for Social Service Agency Transportation Providers." Center for Transportation Research, University of Texas at Austin, Austin, Texas, DOT-1-81-17.

A. U. Simpson (1982), "Computer Methods for Management, Dispatch and Coordination." Specialized Transportation Planning and Practice, Volume 1, Number 2 (1982), pg. 127-135.

Special Note

References for available software are listed in the following publication:

"Microcomputers in Transportation: Software and Source Book, March 1984" UMTA-URT-41-84-1.

Robert E. Paaswell, Director; Claire McKnight, Faculty Associate; and Joseph V. Depa, Urban Transportation Center, University of Illinois at Chicago, Chicago, Ill. 60680.

MICROCOMPUTER APPLICATIONS IN SMALLER PARATRANSIT AGENCIES

Nigel Hamer and Jean-Marc Rousseau

Introduction

The increasing availability of micro-computer hardware and software has opened the door to use of computers by even the smallest companies and agencies. Transit properties are no exception. It is however, often difficult to select the right equipment and the right software. More importantly, it is often a tough job just to decide what areas can benefit the most from computer assistance. This paper attempts first to briefly outline the general approach we feel is most appropriate during system selection. Secondly, we overview some of the functions required for computer-assisted reservation and scheduling in paratransit, one specific area where computer power can be applied.

Hardware and Software Selection

The major pitfall in selecting micro-computers is to start by looking first at the hardware available. In fact, this is the last thing one should do. Begin by surveying needs: where are the bottlenecks in my operations?; where are the repetitive, time-consuming tasks?; where are the areas where better or more timely information could improve operations and/or decision-making? Once this difficult exercise has been completed, the next step is to identify software available that seems to meet these needs. In most cases, "packages" exist for common needs; a small operation can rarely afford custom programming. Seek references from vendors; many promises have been unfulfilled in the computer industry. Insist on demonstrations of working systems versus simulations. The last step is then to choose a micro computer that is able to run the software that meets your needs.

As far as machines are concerned, professional usage of computers requires well-known brand name machines. Good service and future expandability are key criteria. Avoid a machine that merely meets present requirements; down the road, conversion costs to a larger machine will be more onerous than current savings. "Hard" disks rather than "floppy" disks should certaintly be considered as they reduce the amount of data manipulation required. Extra memory may seem a luxury today but "standard" packages now use 4 or 5 times the typical memory available on machines considered state-of-the-art 3 or 4 years ago. In the long run the cost of software and of one's time tends to dwarf hardware costs. Closely examine future needs to see whether multi-user capabilities will be required.

Paratransit Applications

Transit properties can benefit from standard applications: word processing, spreadsheets, accounting packages, and telecommunications software. More specific applications are vehicle fleet maintenance, maintenance inventory, and computer-assisted trip reservation and scheduling for paratransit.

This last application is one that has received much attention because of the need for cost-effective use of specialized transit resources, the often voluminous reporting requirements of the various funding agencies, and the rapid growth of demand for this type of service. In our opinion, a good package in this area must address both management reporting and operational concerns: many systems tend to neglect one or another of these aspects. The first function required is that of client registration, with reference and updating capabilities. The client file so constituted can be used for mailing lists, management reports and statistics, eligibility verifications, etc.

Trip reservation is a second function that can be implemented. This is a pre-requisite for computer-assisted scheduling and a valuable source of information on ridership for billing and statistical purposes. The actual reservation process may not be greatly speeded up but many auxiliary functions can be automated. In addition, by keeping in memory for each client his usual trips, one can eliminate most of the time the onerous task of taking down detailed addresses. In fact from recent experiences we can say that 6 out of 7 trip requests are for a trip that the client has already taken in the past. So in most cases the reservationists merely recalls on the screen the details of the previous trip when registering the new request. In addition, if one keeps a set of abbreviations for common public places that clients frequent, the task of copying formal addresses can be greatly reduced.

In the scheduling area, a distinction must be made between computerized aids for the human scheduler and automated scheduling via operations research-type algorithms. For smaller properties it is unlikely that automated scheduling would be useful or effective—it requires fairly sophisticated computer software but mostly the use of some sort of geocoding scheme in order to estimate travel times. On one hand, the construction and validation of a good address to grid data base together with the construction, calibration and validation of an accurate travel time table could be both time consuming and expensive. On the other hand, manual geocoding is time consuming and error-prone, and as-the-crow-flies distance time calculation can often be misleading. While advanced algorithms can produce good solutions when the data used is of good quality, these algorithms could produce useless results if location and travel time data are inaccurate. Computer-assisted scheduling, however, is possible, with the computer screen being employed as a work-pad for route planning: once the routes have been "blessed" by the scheduler they can be printed out on driver run sheets. Cancellations and client inquiries can quickly be processed because all the information is available on-line.

A system of this type may or may not also include driver and vehicle management functions, depending on the other software used by the property. Simple vehicle maintenance reporting could be integrated into a paratransit package. Driver files can be added for payroll, complaint and commendation purposes. For properties operating on a brokerage basis, reports can be generated in order to pay the bus or taxi companies providing the actual service.

Conclusion

In conclusion, micros can and are being used in even the smallest transit properties. Successful use requires a close examination of operations and priorities, followed by a lucid selection process: don't buy the computer first! For paratransit, a step-by-step implementation of registration, reservation and scheduling functions is suggested. In our opinion it pays to first concentrate on data management functions and to leave scheduling algorithms alone until the load reaches several hundred trips a day.

Nigel Hammel, GIRO Inc., 5450 Cote Des Neiges Road, Montreal, Quebec, Canada, H3T 1Y6; and Jean-Marc Rousseau, Director, Center on Transportatin Resarch, University of Montreal, Montreal, Quebec, Canada, H3V 1H8.

6

Workshops: The State-Of-The-Art

THE BRITISH COMMUNITY BUS CONCEPT—LESSONS FROM THE SOAR VALLEY EXPERIMENT

J. Abbiss, D. Gillingwater, J. Sutton, and D. Marshall

Introduction and Background

The first community bus project began operation in Norfolk in November 1975. By mid-1978 sixteen community bus projects were operating in several counties in England and Wales, and this had risen to more than 50 in 1984. The community bus has become a popular form of rural transport innovation, with many counties who have yet to sponsor an experiment, actively considering doing so.

The purpose of this paper is to review the role of community buses in rural areas and examine the reasons for their success, using case-study material collected in Nottinghamshire by the Community Transport Services Research Unit (CTRSU) at Trent Polytechnic in Nottingham in the period 1978 to 1984.

The concept of the community bus comprises a partnership between the sponsoring agency (normally the County Council or the National Bus Company) and the local community to be served by the project, and includes the following arrangements.

The sponsoring agency provides the vehicles (usually a minibus, 12 to 17 seats; or a midi bus, 17 to 35 seats), administration and operating costs up to a predetermined level, and gives technical and professional advice, including monitoring of the project.

The local community manages the day-to-day operations on a voluntary basis, including taking bookings and arranging schedules, collecting fares, keeping records, and the recruitment of voluntary drivers.

Because the projects are organised, in the main, on a voluntary basis they provide a low cost solution to the problems of rural areas where little or no conventional public transport exists. In addition, because they are managed by a local operating group of community representatives, they can respond to the transport needs of the local population in a way which conventional bus services would find difficult. An example of this is the provision of services which cut across established "services boundaries," such as providing special services for schools and social service agencies alongside their scheduled operations. In this and other ways they can therefore become the focus of transport coordination and service integration (CTRSU, 1984; Abbiss et al, 1984).

The policy in support of community buses has been helped by recent changes in transport regulations, which collectively allow non-profit making projects to operate without meeting the normal Public Service Vehicle regulations, and bypass the need to gain a Bus Operator's License. Relaxation of these regulations is contained in the 1977 Minibus Act, the 1978 Transport Act, and the 1981 Public Passenger Vehicles Act. A recent Government White Paper on the bus licensing system (DOT, 1984) has proposed further deregulation of conventional bus services with the objective of increasing competition for bus routes; however it seems unlikely that this move will have any direct effect on the sponsorship of community bus projects.

Responsibility for public transport planning in rural areas rests with the Shire County Councils (like Nottinghamshire) in England and Wales, Regional Councils in Scotland, who have a duty to:

(i) develop policies to promote the provision of a coordinated and efficient public transport system to meet the county's need;

(ii) take steps to promote coordination, amalgamation and reorganisation of road passenger transport undertakings in the county, including special transport services;

(iii) prepare and publish by 31 March each year an annual Public Transport Plan for the following 5 year period. This should contain a review of the passenger transport needs of the county; a statement of the County Council's policies and objectives; an estimate of the money required to achieve these; details of consultations carried out; financial arrangements made with operators; and details of concessionary fare schemes for elderly and disabled people.

The preparation of Public Transport Plans including special or unconventional services has encouraged the counties to experiment with unconventional services, and community buses have emerged as a popular option in isolated rural areas.

Support for the experimentation with community buses has come from the Department of Transport, who have themselves sponsored a project in Devon as part of their Rural Transport Experiments program, RUTEX (TRRL, 1980), and also published a guide for community transport operators (DOT, 1978); from a Select Committee of Members of Parliament (Selection Committee, 1978); and from an independent study undertaken by the National Consumer Council in 1978 (Rural Rides, 1978). A summary of the operating charactertistics of 16 selected projects is provided in Table 1.

TABLE 1

Summary Estimates of Operating Statistics of 16 Community Buses in 1978 (at 1978 prices)

Number of Schemes	16
Average population of villages served (excluding destinations)	1600
Number of mini/midi buses used in each project	1
Number of days operated each week	
a) scheduled services	4
b) special services	6
Average number of single passenger journeys on scheduled stage services per week	120
Average weekly revenue	(pounds sterling)
a) scheduled services	15.37
b) special services	8.52
c) total	23.89
Average weekly cost of operation	
a) vehicle operating costs	28.79
b) administration costs	8.28
c) total	37.07
Average weekly operating subsidy	13.18
Average vehicles miles per week	213
Average weekly cost per passenger journey	0.30
Average weekly subsidy per passenger journey	0.11

SOURCE: Select Committee, 1978; Rural Rides, 1978.

Community Buses in Nottinghamshire

As of October 1984, there were three rural community bus schemes in Nottinghamshire sponsored by the County Council, and three other special services worth mentioning which are sponsored by independent voluntary organisations (see Map 1).

The voluntary sector projects do not provide scheduled services but operate on a "group hire model" to other non-profit making groups and provide a range of transport services to handicapped and elderly people to attend health and social services centres. This community transport role was augmented in 1981 by the provision of a Dial-a-Ride service for the disabled—PHAETON—using two specially equipped vehicles. Descriptions of these voluntary sector schemes have been provided elsewhere (Community Transport Quarterly, 1983; TSRU, 1983).

Nottinghamshire was one of the first counties to experiment with community buses, beginning in 1978 with the Bassetlaw Community Bus, and has subsequently accumulated six years operating experience. Simultaneously, the local communities served by the projects have learnt to "fine tune" the services to their needs and the resultant symbiosis between the community and the bus services has become an important factor for consideration when the Council undertakes its annual evaluation of the projects. A summary review and evaluation of the Bassetlaw and Countryman community bus projects is provided below; the Soar Valley project will be considered in more detail later.

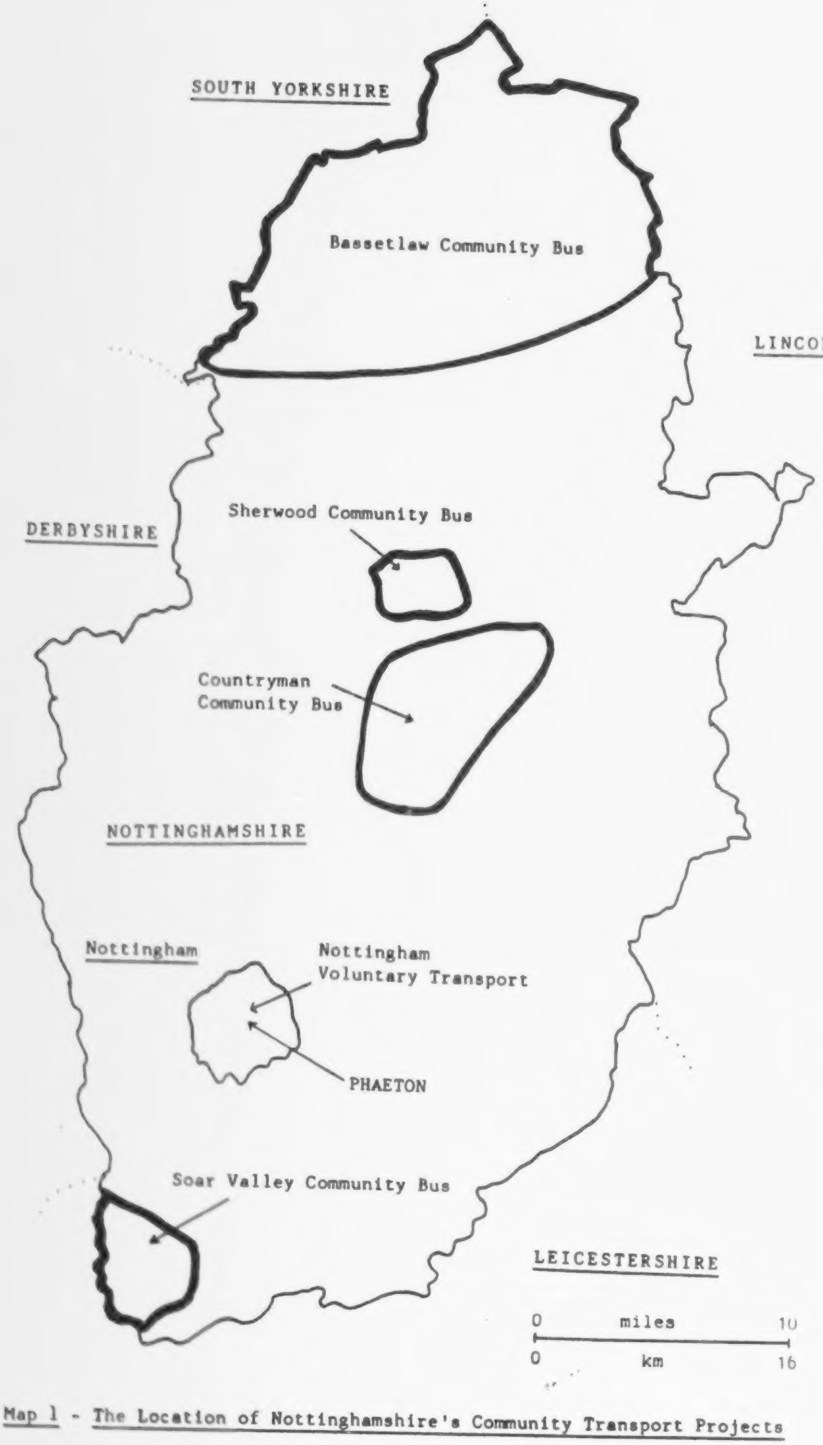
1. The Bassetlaw Community Bus was the first such experiment in the UK to operate after the 1978 Transport Act relaxed the licensing regulations. Whilst the project conforms to the partnership principles and dual purposes of other projects, in three specific areas it is unique. Firstly, the area of operation is large (250 sq km) and includes 34 settlements with a total population of 12,000. Secondly, whilst the project is managed by a local voluntary committee, the bus is owned and operated by a local bus company on an annual contract (the County Council providing the revenue support), and is not therefore driven by volunteers. Thirdly, the midi-bus sized vehicle (20 seats) is equipped with a tail lift for wheelchair passengers.

The size of the area to be covered and the special design of the vehicle to be used persuaded the County Council to fund a professionally driven service as a special experiment, outside of its normal revenue support payments to scheduled bus operators. The project was suggested following a study undertaken by the County Council's Planning and Transportation Department into accessibility to rural services in Bassetlaw (Childs, 1978). This study identified particular problems of gaining access to health facilities and social services centres, alongisde more general problems of access to shopping and leisure facilities. These problems were especially important to elderly and disabled people and the requirement was therefore to operate a special bus with a tail lift.

The size of the net deficit and the comparatively high level of subsidy per passenger has threatened on more than one occasion in the six years of its operation to reduce the number of services operated, but on the credit side the use of the bus has reduced the expenditure on school contracts and social services work though this is not recorded in the internal audit of operations. Perhaps most persuasively of all, however, is the wide support for the service from the local community and politicians, and the recognition that in overall terms the project is judged a success and could not be provided any cheaper by other means. Finally, in March 1984, the County Council reaffirmed their support to the project by approving 5,000 pounds sterling towards the cost of a replacement vehicle.

The operating performance data of the Bassetlaw community bus is shown in Table 2.

2. The Countryman Community Bus Service. Unlike the Bassetlaw project, the Countryman project corresponds more closely to the ideal community bus model. The area of operation extends over ten small settlements with a combined population of 1,500; the vehicle is



Map 1 - The Location of Nottinghamshire's Community Transport Projects

TABLE 2

Operating Performance of the Bassetlaw Community Bus

	1983/84	*1982/83*
One-way passenger trips by services;		
school	3,712	4,304
shopping	14,000	10,263
health and welfare	3,496	3,575
leisure	2,058	1,208
private hire	560	310
total	**23,853**	**19,660**
Costs (pounds sterling): Basic Contract		
drivers hours *	11,792	11,203
mileage **	6,788	7,114
administration	1,440	1,375
private hire	315	245
total	**20,335**	**19,937**
Revenues (pounds sterling):		
Bassetlaw School Contract	6,337	7,080
concessionary fares (elderly and handicapped)	513	600
on-bus fares	1,213	705
off-bus fares	1,445	1,250
private hire	377	250
total	**9,885**	**9,885**
Net Deficit (pounds sterling)	10,450	10,052
Subsidy per passenger journey (pence)	43.8	51

* 49.3 hours per week

** 29905 miles

SOURCE: Environment Committee Report, 14 March 1984, Nottinghamshire County Council.

managed and operated by volunteers; and the vehicle used is a 12 seat minibus. The service operating statistics and performance are summarised in Table 3.

In 1983/84 the project is expected to make another operating profit, of 400 pounds sterling. This excludes the vehicle depreciation and replacement cost, which if included in the audit would result in a net annual cost of the scheme of 1,760 pounds sterling, equivalent to a 33 pence subsidy per passenger journey.

Both these projects are considered to be successful and continue to receive financial support, and as intimated previously their success is judged on social criteria as much as on financial performance. In order to investigate the social impact of community bus projects on local communities it was decided to investigate one project, the Soar Valley Community Bus, in detail. The results of this case-study are presented below.

The Soar Valley Community Bus

The project began in September 1979 and has since been closely monitored by the County Council and the CTSRU, who collaborated in a travel survey of the area in October 1979. The project is organised in a similar way to the Countryman project (which it preceded), with a Parish Operating Group controlling the day-to-day management and organising voluntary drivers.

The settlement geography of the area is illustrated in Map 2, showing the spatial distribution of population and activities and the route of an existing scheduled bus service. The major transport problem in the area arises from the absence of a public transport link from the Soar Valley to East Leake and West Bridgford where many activities are located, including the secondary school, health centres, sports centre and Council offices. In addition, the project aimed to provide a limited schedule service into Loughborough, the local market town situated in north Leicestershire, for three of the settelements which have no scheduled bus services.

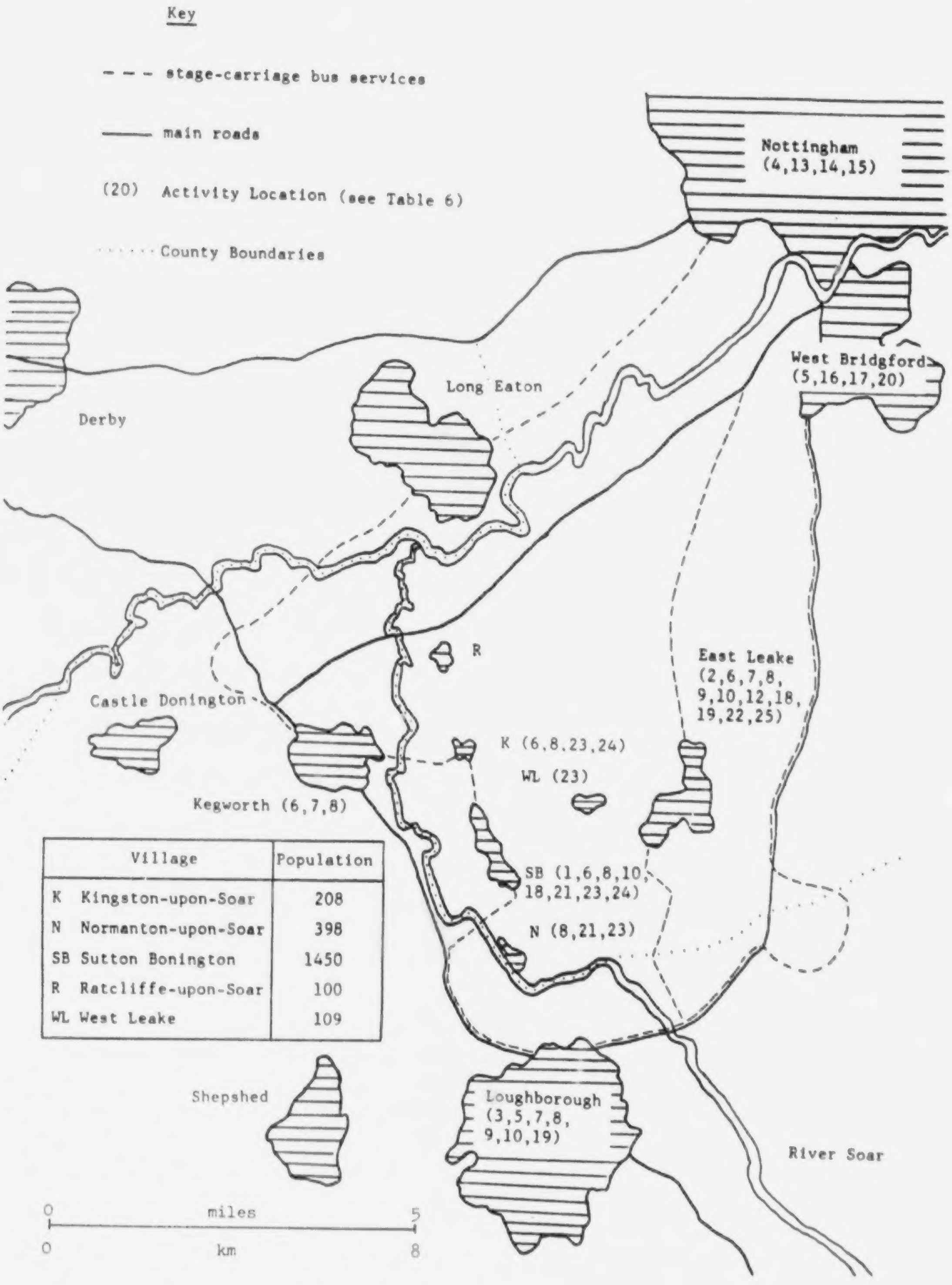
In monitoring the project three exercises were conducted:

- a travel questionnaire survey of 2,265 people in 789 households (94% of the households in the area)
- an analysis of patronage on the existing bus service, by destination, journey purpose and frequency
- an accessibility analysis using the data collected and incorporating a time-geographic approach.

(i) The household questionnaire survey revealed high household car ownership rates averaging 81.2 percent. In addition 30 percent of the households owned two or more cars. However, a breakdown of driving license ownership reveals that whilst male driving license ownership is near the car ownership level (at 80 percent), only 51.7 percent of adult females own a driving license. The implication of this being that many women must rely on other forms of transport other than a car for their mobility, especially when the family's only car is not available. The survey also identified 113 handicapped people (5 percent) who could not use the car or local bus service unaided. Amongst the 245 elderly people, driving license ownership is similar to that of women.

An analysis of local trip patterns demonstrates the dominance of the car mode amongst none-elderly adults, but also shows that a significant number of people rely on the bus mode (Table 4). Of particular interest are the travel modes of elderly people, which are compared to those of other adults for shopping and leisure journeys in Table 5.

Whilst the car is still the most popular mode (reflecting the increasing car ownership rates among the elderly), the bus mode is especially important amongst the elderly for shopping and leisure activities.


Key
stage-carriage bus services
main roads
(20) Activity Location (see Table 6)
County Boundaries
Nottingham (4,13,14,15)
West Bridgford (5,16,17,20)
Derby
Long Eaton
R
East Leake (2,6,7,8, 9,10,12,18, 19,22,25)
Castle Donington
K (6,8,23,24)
WL (23)
Kegworth (6,7,8)
SB (1,6,8,10, 18,21,23,24)
N (8,21,23)
Shepshed
Loughborough (3,5,7,8, 9,10,19)
River Soar
0 miles 5
0 km 8

Village	Population
K Kingston-upon-Soar	208
N Normanton-upon-Soar	398
SB Sutton Bonington	1450
R Ratcliffe-upon-Soar	100
WL West Leake	109

Map 2 - The Soar Valley Base Map

TABLE 3

Operating Performance of the Countryman Community Bus

	1982/83
One-way passenger trips:	
shopping and personal business	1,633
school	3,500
leisure	183
total	**5,316**
Costs (pounds sterling):	
fuel	440
maintenance	254
insurance/tax	295
Parish Operating Group expenses	82
other (publicity, etc.)	20
total	**1,091**
Revenues (pounds sterling):	
on-bus fares	580
scholars season tickets	345
private hire	285
concessionary fares (elderly and handicapped)	360
total	**1,570**
Net Operating Profit	479

SOURCE: Environment Committee Report, 22 February 1984, Nottinghamshire County Council.

TABLE 4

Travel mode and journey purpose amongst non-elderly adult Soar Valley residents (October 1979)

Average weekly frequency

	All Journeys		*Work*		*Shopping*		*Leisure*	
	#	%	#	%	#	%	#	%
Car Driver	777	54.5	263	60.1	303	50.5	211	54.0
Car Pass.	195	13.7	20	4.5	92	15.3	83	21.2
Bus	219	15.3	36	8.2	130	21.6	52	13.5
Walk	107	7.5	40	9.1	46	7.6	21	5.3
Bicycle	92	6.4	52	11.8	25	4.1	15	3.8
Motorbike	33	2.3	23	5.2	3	0.5	7	1.7
	1423	100	434	100	600	100	390	100

Note: Total percent are rounded in Tabless 4, 5, 6.

TABLE 5

Comparison of elderly and other adult travel modes in the Soar Valley (October 1979)

	Shopping		**Leisure**	
	*Elderly**	*Other Adults*	*Elderly**	*Other Adults*
	%	%	%	%
Car Driver	43.7	50.5	52.7	54.0
Car Passenger	8.3	15.3	13.8	21.2
Bus	38.5	21.6	25.0	13.5
Bicycle	3.1	4.1	5.5	—
Walk	6.2	7.6	2.7	5.3
	100	**100**	**100**	**100**

* Women 60 years and over. Men 65 years and over.

TABLE 6

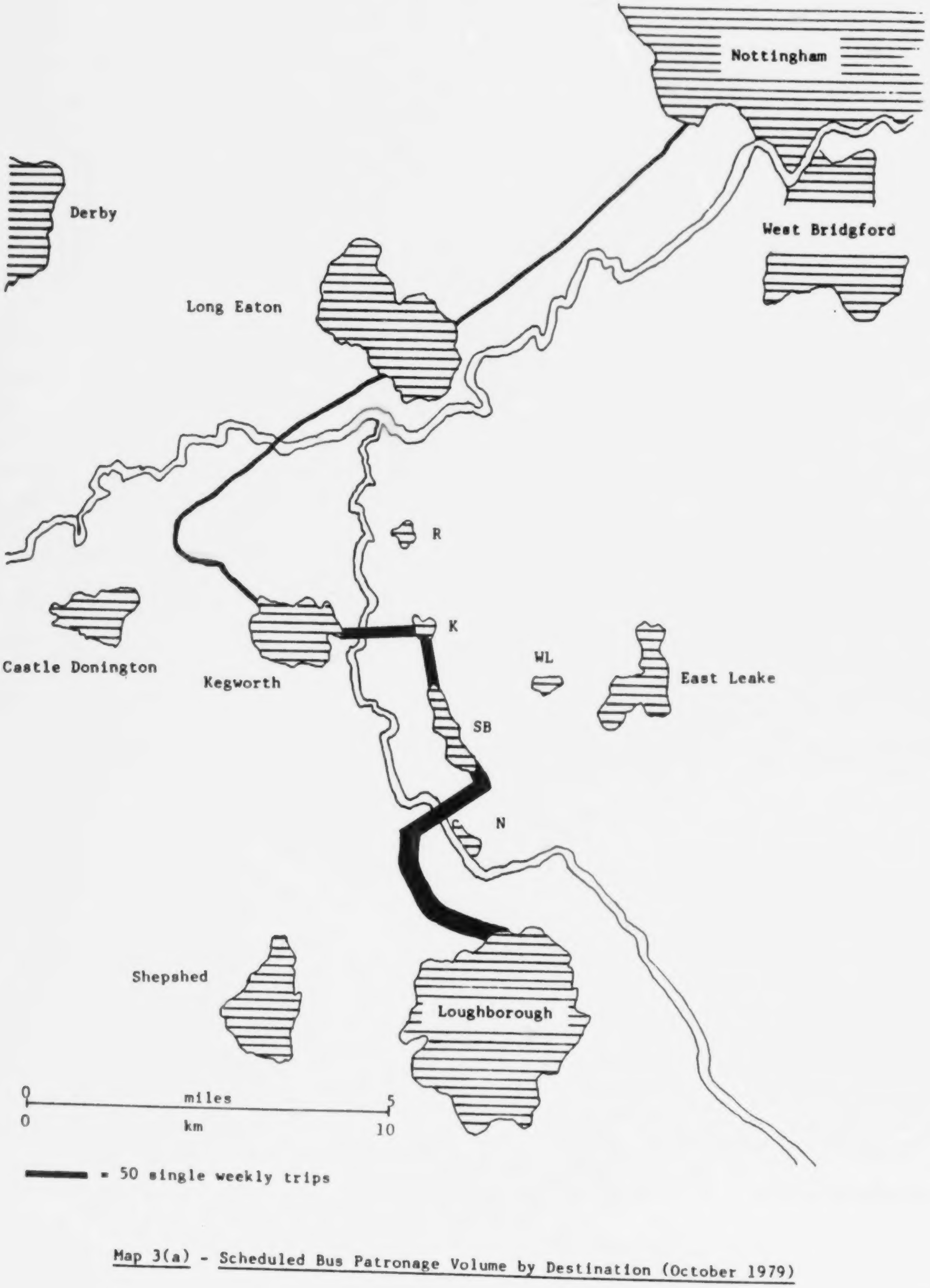
School children's travel modes in the Soar Valley area (October 1979)

	Non-school Journeys	
	#	%
Car Driver	9	6.0
Car Passenger	83	56.0
Bus	27	18.2
Bicycle	26	17.5
Walk	3	2.0
Total	**148**	**100**

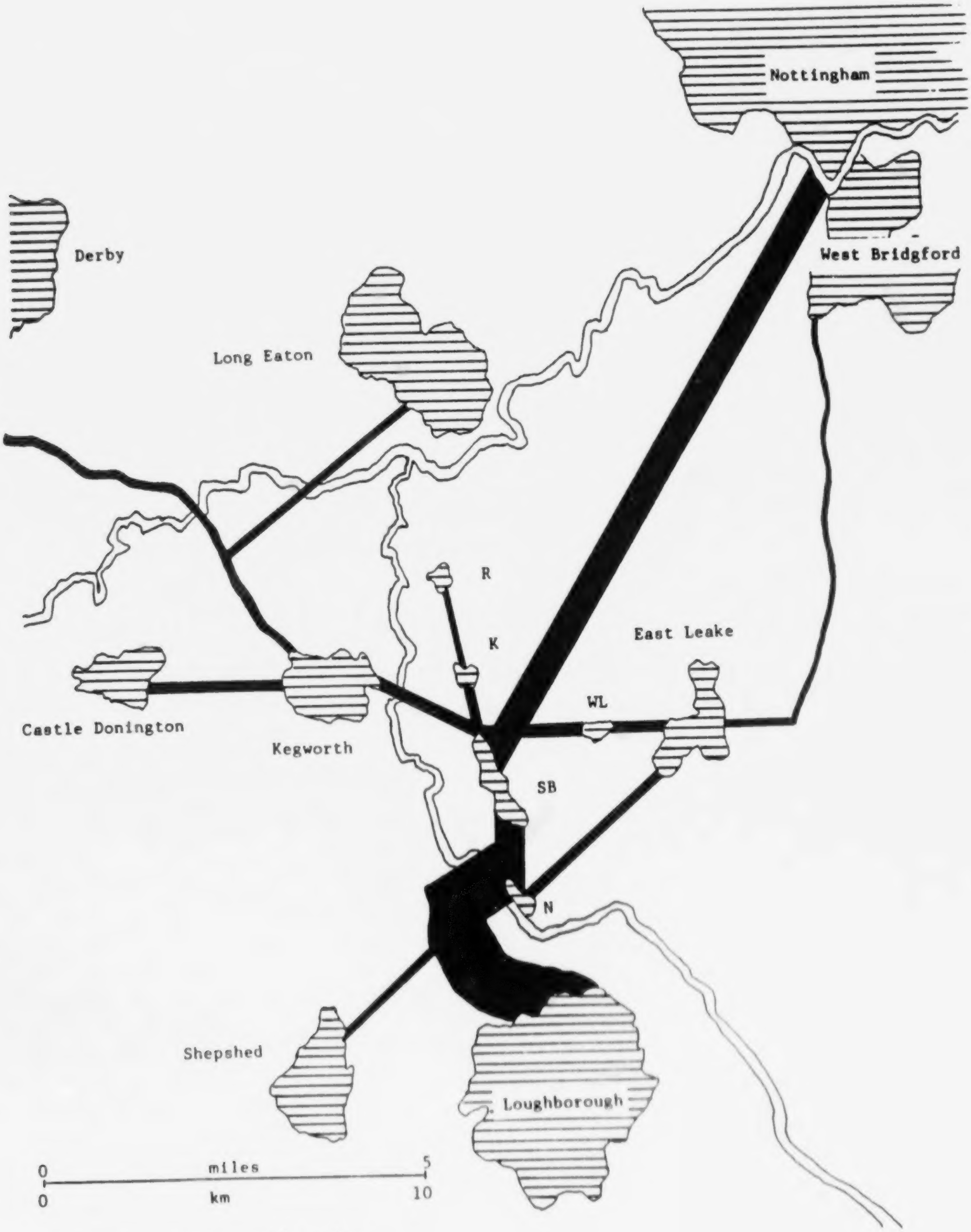
The survey also collected information on secondary school children's (11-18 year olds) travel patterns for non-school activities which also reveals their dependence upon the family car for mobility, followed by the bus mode (Table 6). Taken together the survey revealed a significant dependence on bus services even in an area of high household car ownership: in particular, amongst the elderly, women who cannot drive and school children. These groups in the community must rely on both the family car and the availability of a driver and on the local bus service.

(ii) The analysis of the local scheduled bus service was taken to plot the destinations of bus passengers, and these are illustrated in Map 3a. The corresponding travel destinations of car users is illustrated in Map 3b. The maps show trip frequencies by destination, utilising data collected from a survey of bus patronage and from the household survey.

The maps show clearly the differences between car travel and bus travel, both in terms of the frequency of use of each mode and by destination. Assuming that the free choice of destination available to car users is desired in a similar way by bus users, the analysis highlights the restricted destination choice available to bus passengers and identifies those destinations to which there is an access problem. Principally, this is the East Leake to Nottingham corridor via West Bridgford and to a lesser extent access from three of the settlements to



Map 3(a) - Scheduled Bus Patronage Volume by Destination (October 1979)



Map 3(b) - Single Weekly Car-trips by Volume and Destination (October 1979)

TABLE 7

Latent demand for public transport by destination (October 1979) and actual patronage (September 1979 to June 1980) (single weekly bus journeys)

Destination	*Latent Demand* #	%	*Soar Valley Community Bus actual weekly patronage (Sept 1979—June 1980)* #
Within Soar Valley area	3	1.0	43
Kegworth	9	3.1	7
East Leake	46	17.7	41
Long Eaton	9	3.1	
Loughborough	93	35.4	37
Nottingham	68	26.0	
Derby	5	2.0	
Other	32	11.4	
Totals	**265**	**100**	**128**

TABLE 8

The Accessibility Standards

Activity	*Minimum Frequency (days per week)*	*Maximum Journey Time (minutes)*	*Minimum length of stay possible (hours)*
1. Employment	5	60	8
2. Supermarket	6	30	2
3. General Store	6	20	1
4. Chemist	6	30	1
5. Post Office	1	30	1
6. Bank	1	30	1
7. General Doctor	5	30	2
8. Dentist	5	30	2
9. Health Centre	5	30	2
10. Hospital	7	60	2
11. Job Centre (Govt. Employment Office)	1	30	3
12. Social Security Office	1	30	3
13. District Council Office	1	30	2
14. County Council Office	5	30	2
15. Library	5	30	2
16. Evening Classes	5	30	2
17. Technical College	5	30	8
18. Primary school	5	30	7
19. Secondary School	5	30	7
20. Public House	2	30	2
21. Community Centre	1	30	3
22. Sports Centre	1	30	2

Loughborough. The household survey asked questions on travel problems and calculated a latent demand for bus travel of 265 single weekly bus journeys per week, distributed by destination in Table 7.

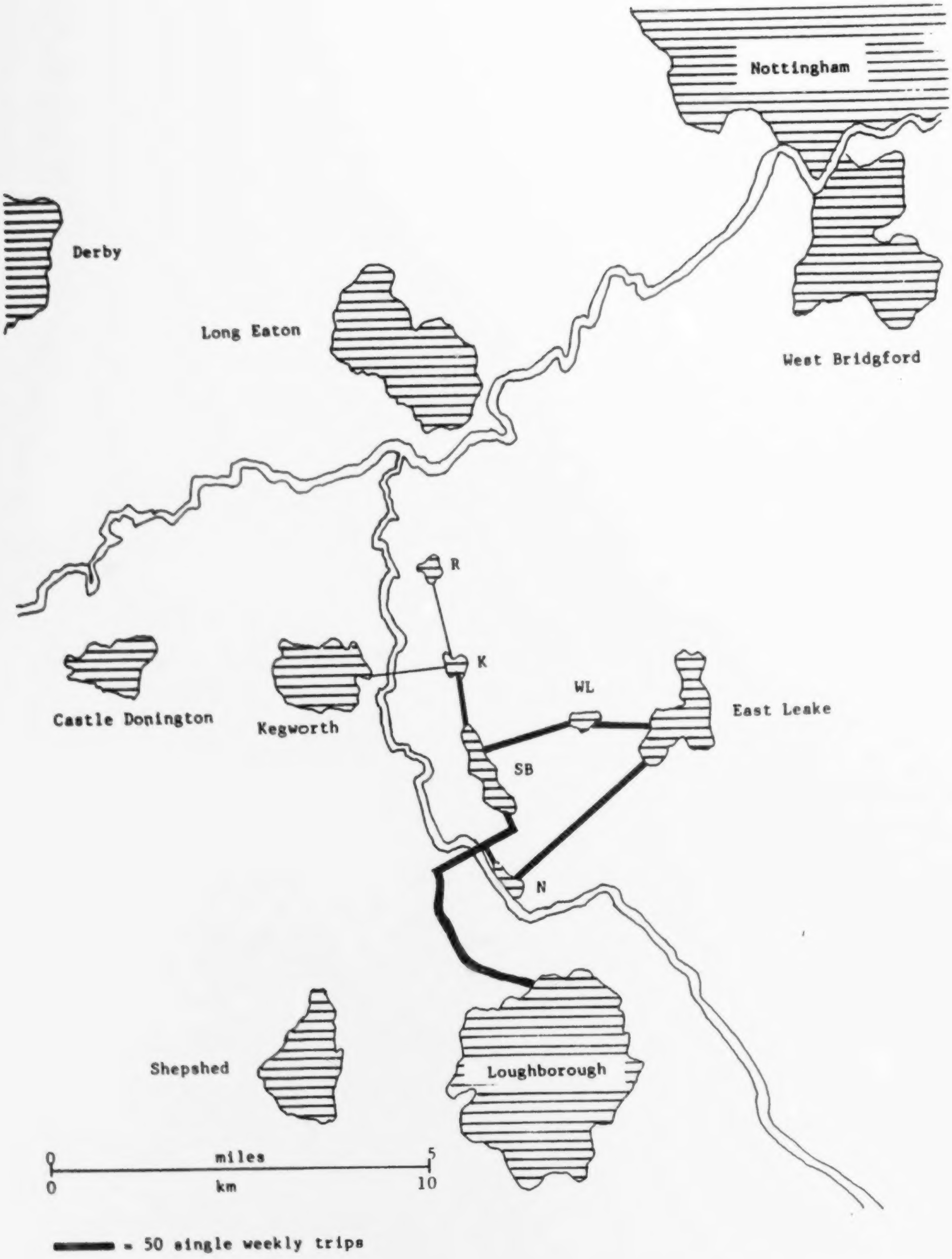
Table 7 also compares the actual performance of the community bus in satisfying latent travel demands. The figures only show patronage by community bus destination, and some of those travelling to East Leake, for example, will be able to connect with a scheduled bus service to West Bridgford and Nottingham (Map 3c). This analysis indicates the spatial performance of the project, and especially in providing a means of accessibility to East Leake, and of enhanced mobility within the Soar Valley area. By June 1980 the Soar Valley community bus was responsible for a 48 percent increase in bus patronage by residents in the area, over and above the existing scheduled service. This statistic demonstrates the trip generation qualities of the project, and the correctness of the decision to improve accessibility to the East Leake to Nottingham corridor.

(iii) The accessibility analysis. The purpose of the accessibility analysis was to indicate those activities which were inaccessible, before and after the introduction of the community bus and, using the survey data, to estimate the proportion of the local population who are "mobility deprived."

The method of undertaking an accessibility analysis is relatively straightforward and involves the following exercises:

1. Specifying the activities to be included and their spatial location (Map 2).
2. Defining accessibility standards for each activity in terms of frequency of access, length of stay and maximum journey times acceptable in order to reach an activity (Table 8).
3. Defining maximum walking times from home to the nearest bus stop (half mile or 10 minutes) and between the journey destination and the nearest bus stop.
4. If the activity cannot be reached or take place within the defined standards the access score is zero. If the activity is possible it scores one (Table 9).
5. For each activity which is inaccessible, estimates of the number of people affected are computed from the household survey data base (Table 10).

The methodology was originally designed and tested in an accessibility study conducted by Moseley et al in 1977 and has since been incorporated into several transport studies (Wytconsult, 1977; Banister, 1980; Peat, Marwick, Mitchell, 1980; Martin Vorhees, 1982). The normative establishment of minimum standards of service has been criticised for being "unscientific" but the simplicity of using the technique, once the necessary information has been collected, has benefits for examin-



Map 3(c) - Community Bus Patronage by Volume and Destination
Average Single Weekly Journeys (September 1979 - June 1980)

TABLE 9

The Accessibility Scores for the Five Settlements—Impact of the Community Bus

	Sutton Bonnington		*Normanton-upon-Soar*		*Kingston-upon-Soar*		*West Leake*		*Ratcliffe-upon-Soar*	
	SC	*SVCB*	*SC*	*SVCB*	*SC*	*SVCB*	*SC*	*SVCB*	*SC*	*SVB*
1. Employment within Soar Valley	1		1		1		0	1	1	
2. Employment East Leake	0	1	0		0		0	1	0	
3. Employment Loughborough	1		1		1		0		1	
4. Employment Nottingham	0		0		0		0		0	
5. Supermarket	1		0	1	1		0	1	1	
6. General Store	1		1		1		1		1	
7. Chemist	1		0	1	1		0	1	0	
8. Post Office	1		1		1		1		1	
9. Bank	1		1		1		0	1	1	
10. General Doctor	1		1		1		0	1	0	
11. Dentist	1		0	1	1		0	1	0	
12. Health Centre	0	1	0	1	0		0	1	0	
13. Hospital	1		0		1		0		0	
14. Job Centre	0		0		0		0		0	
15. Social Security	0		0		0		0		0	
16. District Council	0	1	0	1	0		0	1	0	
17. County Council	0	1	0	1	0		0	1	0	1
18. Library	1		1		1		0	1	1	
19. Evening Classes	0		0		0		0		1	
20. Technical College	0		0		0		0		0	
21. Primary School	1		1		1		0		0	
22. Secondary School	0	1	0	1	0		0	1	0	
23. Public House	1		1		1		1		1	
24. Community Centre	1		0		1		0		1	
25. Sports Centre	0	1	0	1	0	1	0	1	0	1
Accessibility Score Change (maximum possible score = 25)	14	20	9	17	14	15	3	16	9	12

Key
1 = accessible
0 = inaccessible
SC = existing stage-carriage bus service
SVCB = Soar Valley Community Bus

ing alternative courses of action within the policy-making process. In this case-study, empirically collected data is used within the accessibility analysis, which enhances both the validity and relevance of the technique.

The time-geographic approach to accessibility used in this study, as originally formulated by Hagerstrand (1970, 1974), is particularly suited to examining the potential of small scale experiments like the community bus projects. Using the dimensions of time and space, the analysis produces "time-space prisms: within which accessibility is possible. Figure 1 illustrates the "time-space prisms" within which travel by stage-carriage bus and the community bus is possible. Increasing the area of accessibility can be achieved by extending the schedules of current services, extending the choice of destination or a combination of both.

The selection of the activities and minimum standards of access are derived from Moseley's criteria for rural areas and modified according to local policy in Nottinghamshire (as defined in the County's Public Transport Plan, 1970-1984). Altogether 22 activities were selected (Table 8) and minimum standards of access, within defin-

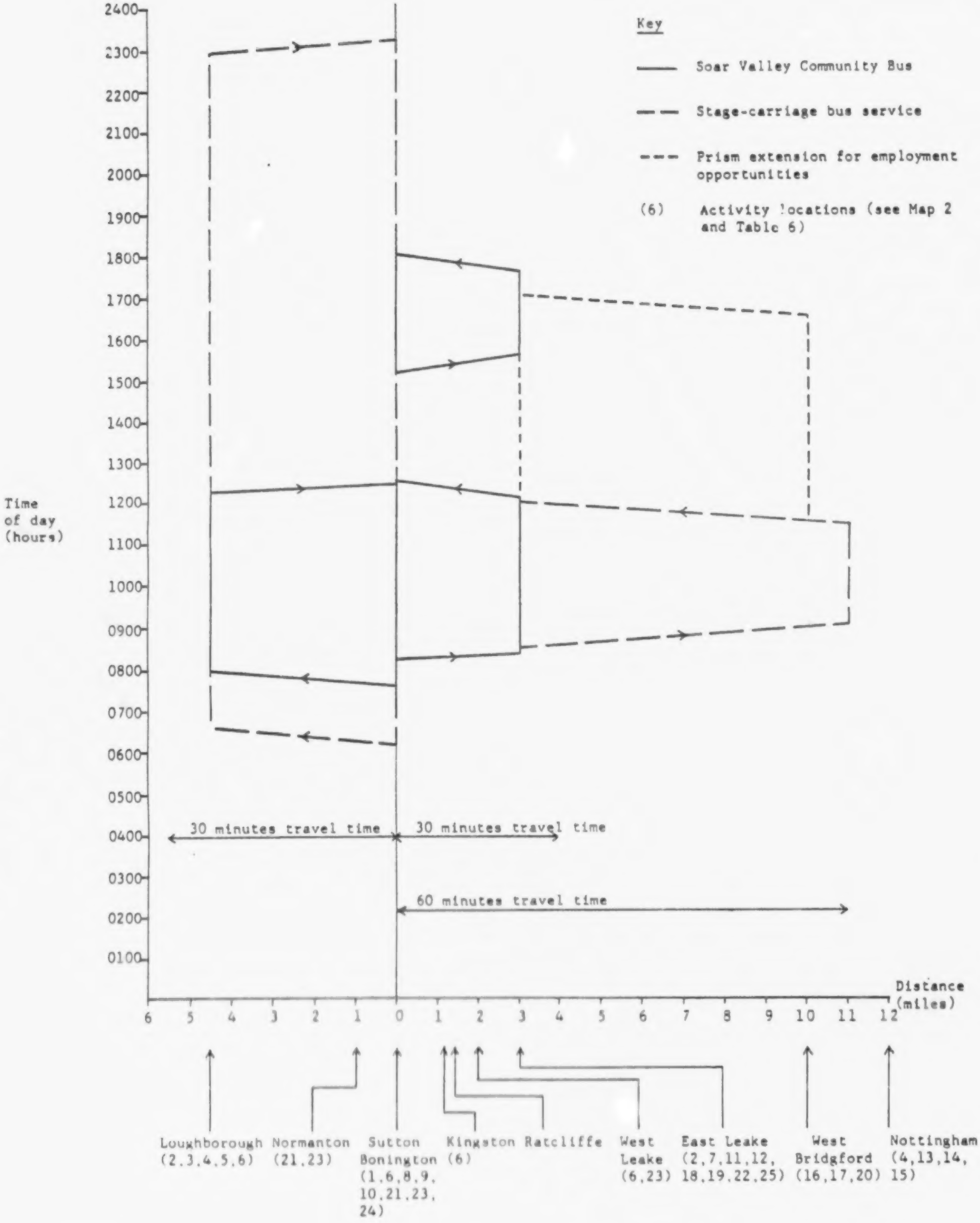


FIGURE 1 Time-Space Accessibility Prisms

ed time-sclaes, were specified. The activities selected include: access to four employment locations; access to nine shopping and personal business activities; access to four health activities; access to five educational activities; and access to three leisure activities. Not all these activities are relevant to all the different social and age groups, and hence the reason for computing the numbers deprived of adequate mobility for each activity in Table 10.

The accessibility score calculated in Table 9 illustrates those activities which are accessible from each settlement in the project area. The computed scores also show the impact of the community bus in improving access: in four settlements there has been a significant improvement (the exception being Kingston-upon-Soar), with particularly noticeable benefits to residents in West Leake and Normanton-upon-Soar. In rank order, the accessibility potential of each settlement, before and after the community bus, is as follows:

Access Score (maximum = 25)

Bank	*Before the community bus*	*After the community bus*
1	14 (Sutton Bonington) (and)	20 Sutton Bonington
2	(Kingston-upon-Soar)	17 Normanton-upon-Soar
3	9 (Normanton-upon-Soar) (Ratcliffe-upon-Soar)	16 West Leake
4		15 Kingston-upon-Soar
5	3 West Leake	12 Ratcliffe-upon-Soar

Despite these improvements many of the activities remain inaccessible and the next stage in the analysis was to calculate the number of people affected by their continuing isolation.

Table 10 summarises the results of this exercise and identifies those activities for which there has been a considerable improvement and those for which problems still remain. For example, significant improvements have been gained in accessibility to the supermarket, chemist, health centre, the District and County Concil offices, the secondary school and to the sports centre: whilst the major inaccessibility problems remain to employment activities in Nottingham, evening classes, the technical college and the primary school. The results also show that for most other activities only a relatively small proportion of the local population are denied access.

The advantage of disaggregating accessibility by settlement and activity in this way, is that it becomes possible to examine the possible range of improvements required to reduce the remaining accessibility inequalities. For example, improving access to the technical college in West Bridgford and to employment opportunities in Nottingham, could be achieved by extending the existing community bus service to East Leake eastwards, to connect with the main Loughborough to Nottingham bus services. Conversely, the problem of access to the primary school and to evening classes is not one of destination but of the scheduling of services, that is, temporal rather than spatial. Another area of concern is access to the doctor, health centre and hospital, especially for the elderly, even though the numbers may be small. The solution for such a small number may be to organise a voluntary car scheme for health journeys.

In this way, the analysis helps us to identify a primary bus network of stage-carriage bus services, a secondary community bus network and a possible tertiary network of voluntary car services, with each level in the hierarchy providing access possibilities defined by dimensions of destination and time.

TABLE 10

The Percentage Affected by Mobility Deprivation before and after the Community Bus

Activity	*Before (%)*	*After (%)*	*Changes (%)*
1. Employment within Soar Valley	2.5	2.5	0
2. Employment East Leake	3.2	1.8	-1.4
3. Employment Loughborough	5.3	1.8	-3.5
4. Employment Nottingham	29.1	29.1	0
5. Supermarket	9.3	—	-9.3
6. General store	—	—	0
7. Chemist	11.0	2.7	-8.3
8. Post Office	—	—	0
9. Bank	2.0	—	-2.0
10. General Doctor	4.2	4.2	0
11. Dentist	2.1	2.1	0
12. Health Centre	13.0	2.4	-10.6
13. Hospital	4.8	4.8	0
14. Job Centre	2.8	2.8	0
15. Social Security	2.8	2.8	0
16. District Council	18.8	1.8	-17.0
17. County Council	18.8	1.8	-17.0
18. Library	4.4	—	-4.0
19. Evening Classes	18.8	18.8	0
20. Technical College	18.8	18.8	0
21. Primary School	19.7	19.7	0
22. Secondary School	26.3	4.8	-21.5
23. Public House	—	—	0
24. Community Centre	4.4	4.4	0
25. Sports Centre	18.8	—	-18.8

The evaluation of the Soar Valley community bus has demonstrated its impact in improving accessibility and mobility choice to non-car users in the area. The resultant improvements are especially beneficial to elderly people in respect of journeys for shopping and personal business. An example of this is a special service operated on one afternoon each week to a supermarket on the southern periphery of Nottingham. Statistics collected for the first quarter of 1984 reveal that, on average, 346 passengers are carried each week on scheduled services, including 53 elderly people (15.3 percent); this compares with 128 per week in its first nine months of operation in 1979-1980. The success of the project in attracting passengers to both scheduled and special services has resulted in only a 12 pence subsidy per passenger, the lowest of the three projects when all costs are considered.

The project is also judged a success by the local community who have supported the scheme enthusiastically from the beginning. The social benefits of the project, apart from the measured reductions in mobility deprivation, are associated with the increasing social interaction between villagers, as evidenced by an increase in organised social activities which rely upon the community bus (eg. elderly persons outings) and the more regular social contacts between people in adjacent villages (approximately 33 percent of the community bus journeys are undertaken totally within the Soar Valley area). These social effects should not be underestimated, because they support directly the revenues collected and indirectly promote awareness and a local sense of pride in the project. Similar sentiments are also expressed by residents in the other two project areas.

Conclusion and Recommendations

The success of the Soar Valley project has been sufficiently encouraging to persuade the County Council to examine the areas where a community bus would be successful—the Countryman project is one example. However, to date, only rural areas have been considered, primarily because the community bus concept is regarded as a low cost alternative to more costly conventional services in areas where demand is low. The experience in Nottinghamshire suggests that the community bus model is sufficiently robust and flexible to operate in a number of different environments meeting wide range of needs, as the contrast with the Bassetlaw and Countryman projects demonstrate. It is worthwhile considering the role of community buses not as cheap substitutes for conventional services but as valuable additions to the local passenger transport hierarchy, meeting a range of needs which conventional services are unable or unwilling to provide. Examples of this are the hire of the vehicle to a local group, or the provision of special shopping services to elderly or handicapped people. The successful implementation of the project is also critically dependent upon the support and commitment of the local community and the abilities of the volunteer organisers.

In accessibility terms the community bus is most successful in meeting "secondary needs," for shopping and personal business journeys, and appears too limited in scope to cater to regular employment activities. The analysis of the Soar Valley project has demonstrated the impact of the community bus in a relatively small area, with measurable improvements in the level of mobility choice available to local residents and reductions in the level of mobility deprivation. These quantitative factors, together with the flexible use of the services in meeting locally expressed needs, presents a persuasive argument for experimenting with the model in urban areas, both suburban and inner city, where in the case of the latter special needs groups are often concentrated and where levels of car ownership, and more importantly of car use, are low. If, as hypothesised here, the community bus fills a niche in the passenger transport hierarchy to good effect in rural areas, there is no reason to suppose it would be no less successful in urban environments. In fact, we contend, one could reasonably assume they would be more successful.

Current policy is to restrict community bus projects to rural areas, and current licensing restrictions would make it difficult to conduct an exact replica of the Soar Valley or Countryman projects in a town or city. Nevertheless, the possibility remains, and at the very least the community bus projects have demonstrated the success of combining scheduled and private hire services from a community base. This lesson, we believe, will be of immense value to transport planners in the future.

References

Abbiss J., Gillingwater D., Marshall D., and Sutton J., "Strategies for the Organisation and Provision of Special Transport Services," PTRC Summer Annual Meeting, Brighton, 1984, pp. 141-152.

Banister D., "Transport Mobility and Deprivation in Inter-Urban Areas," Saxon House, Farnborough, 1980.

Childs R. J., "Nottinghamshire Rural Transport Experiments: The Bassetlaw Community Bus," Nottinghamshire County Council Department of Transportation, NCC, Nottingham, 1978.

"Community Initiatives and Transport Issues," Proceedings of a seminar held on 4 March 1982, CTRsU, Trent Polytechnic, Nottingham, 1983.

CTSRU, "Community Transport Initiatives and Public Transport Planning," Proceedings of a seminar held on 22 June 1983, Trent Polytechnic, Nottingham, 1984.

Department of Transport, "A Guide to Community Transport," HMSO, 1978.

Department of Transport, Buses, Cmnd 9300, HMSO, London, 1984.

Hagerstrand T., "What About People in Regional Science?" Papers; of the Regional Science Association, 24, 1970, pp. 7-21.

Hagerstrand T., "The Impact of Transport on the Quality of Life," Topic 5, in "Transport in the 1980-1990 decade," ECMT 5th Symposium, Athens, Greece, 1974.

Martin Vorhees Associates, "The Lewes Area Public Transport Study," MVA, London, 1982.

Minibus Act, 1977, HMSO, London.

Moseley M. J. et al, "Rural Transport and Accessibility," 2 volumes, Centre of East Anglian Studies, University of East Anglia, Norwich, 1977.

Nottinghamshire County Council, Public Transport Plan 1970 84, Department of Planning and Transportation, NCC, Nottingham, 1979.

Peat, Marwick, Mitchell and Co., "The Assessment of Needs for Rural Public Transport," (A study for Dyfed County Council, Wales), PMM, London, 1980.

Public Passenger Vehicles Act, 1981, HMSO, London.

"Rural Rides — Experiments in Rural Public Transport," National Consumer Council, 1978, London.

Select Committee on Nationalised Industries, "Innovations in Rural Bus Services," Eighth Report, HMSO, 1978, London.

"Special Feature on Nottinghamshire," Community Transport Quarterly, Volume 2, No. 1, 1983, pp. 8-19.

Transport Act, 1978, HMSO, London.

TRRL, "The Rural Transport Experiments. Proceedings of a Symposium" held at the Transport and Road Research Laboratory, 8 November 1979, Supplementary Report 584, Crowthorne, 1980.

Wytconsult, "Analysis of Personal Accessibility in Freestanding Towns," Document 431, West Yorkshire Transportation Study, West Yorkshire County Council, 1977.

James Abbiss, and David Marshall, Community Transport Services Research Unit, Trent Polytechnic, Nottingham, England, NG1 4BU; David Gillingwater, and John Sutton, Loughborough University of Technology, Loughborough, England LE11 3TU.

STUDY OF RESTRICTED MOBILITY LEVELS AND TRIP CHARACTERISTICS OF THE DISABLED IN JAPAN

Tetsuo Akiyama

Introduction

Measures to improve the mobility of the disabled which were initiated as "the Living Zone Enlargement Movement" in Sendai, Japan, in 1970, have since been improved, but are still insufficient.

In particular, access to existing public transportation systems for severely handicapped people such as wheelchair users is very poor. For example, public buses have no lifts; at railway stations, elevators and escalators for the disabled wheelchairs are rare. Special transport services for the disabled seem to center on transportation to and from school and welfare facilities.

This report summarizes the results of a survey which was carried out among the disabled who live in Machida City, Tokyo.

Survey Methods

A survey questionnaire was administered between December 1982 and January 1983, to physically and mentally handicapped people living in Machida City. Because of the difficulty in obtaining lists of the disabled population for a random sample, the subjects used in this survey were obtained from associations of disabled who offered subjects for this research. The interview was conducted in respondents' homes. Some 360 forms, out of 757 distributed, (48 percent collection rate) were completed. Of these, 292 (including 9 with mental handicap), were valid. Table 1 classifies subjects according to their type of handicap and degree of handicap severity among the total of researched subjects. Some 253 subjects (8 percent of total) had clearly defined severe handicaps. Table 1 shows that the greater the severity of handicap, the higher the percentage of subjects in each population

Aims of the Survey

The main aims of this survey were as follows:

a. To establish the relation between the severity of handicap and walking ability, which is considered to be an indication of level of mobility restriction (vertical and horizontal mobility), and with the ability to use transportation.

TABLE 1

Subjects according to their type of handicap and degree of handicap severity

	Limb and Trunk					*Visually Inpaired*			*Other*		*Total*		
Level of Impairment	*Lowertrunk*												
	A	*B*	*Sub Total*	*B*	*C*	*A*	*B*	*C*	*A*	*C*	*A*	*B*	*C*
1	9	33	42	233	18	21	134	16	11	8	74	503	15
2	11	46	57	418	14	4	77	5	11	8	72	633	11
3	4	15	19	357	5	4	36	11	11	6	34	575	6
4–6	36	11	47	891	5	7	149	5	19	8	73	1,277	6
	60	**105**	**165**	**1,889**	**9**	**36**	**396**	**9**	**52**	**6**	**253**	**2,988**	**8**

Note: A) Subjects with known type of handicap and degree of handicap severity

B) Population of handicapped persons

C) A + B × 100

292 questionaire forms were valid including 9 with mental handicaps and 30 with unknown degree of handicap severity.

Level of impairment; 1–2 is very severe, 3–4 is severe, 5–7 is appreciable

b. To consider the effect of the mobility restriction level on the frequency of trips.

c. To experimentally examine latent trip frequency or desired trip frequency, to identify the percentage of those who gave up going out and of those who asked others to go out for them.

Mobility Restriction Level and Mobility of the Disabled

We analyzed the relation between walking ability and ability to use transportation, by type of handicap.

Vertical Mobility

Figure 1 shows the percentage of those who have difficulty in dealing with four restrictions on mobility 1) staircase at railway station 2) first step of buses, 3) differences in roads levels 4) difference in road travel, after the level had been lowered, by degree of handicap severity. The results suggest that staircases at stations and the initial step of buses are the two greatest obstacles. Half of the subjects from the third degree (moderately handicapped) to the sixth degree groups had difficulty in negotiating these obstacles.

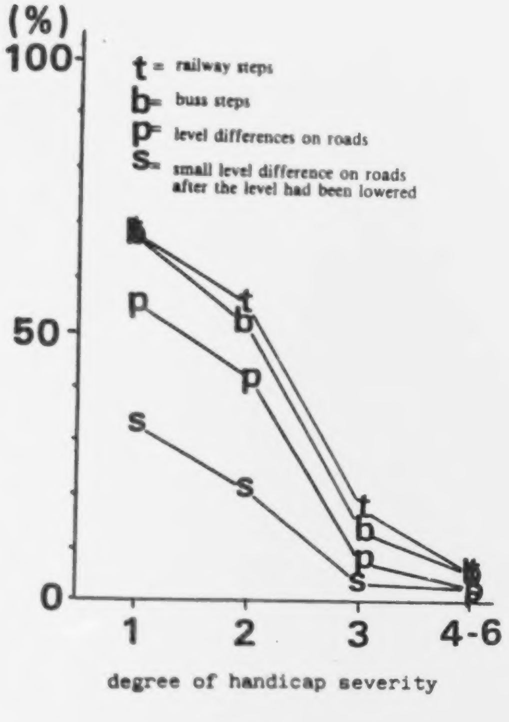


Figure 1

The percentage of subjects who have difficulty in dealing with four mobility restrictions according to the degree of handicap severity

Figure 2 graphs the percentages of subjects who have some difficulty and those who have little difficulty ascending and decending staircases at railway stations. Care should be taken with the interpretation of the results of those with visual handicaps (degree 2 and 3), and lower limb handicap (degree 3) because of the small sample number. The number of trunk-handicapped subjects who have difficulty in negotiating steps is greater than the lower limb-handicapped subjects with the same degree of severity.

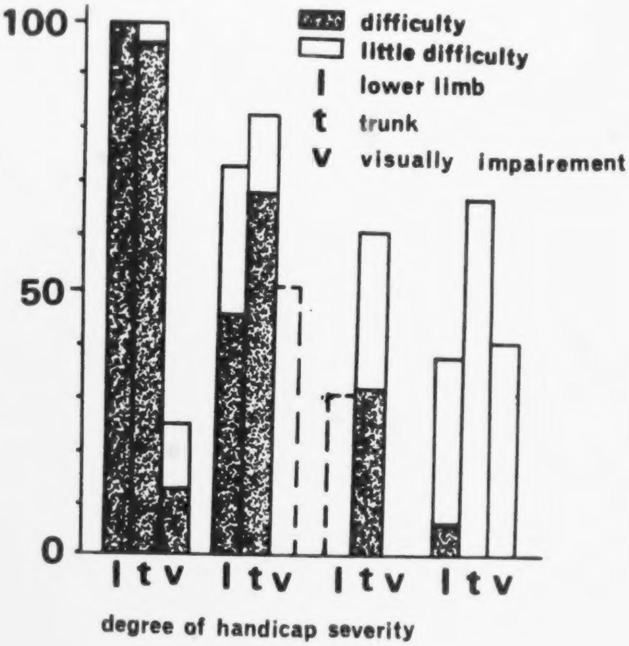


Figure 2

The percentages of subjects who have difficulty and those who have little difficulty in ascending and decending staircases at railway stations

Horizontal Mobility

The percentage of those with waiking difficulties at certain distances in relation to the type of handicap and the degree of handicap severity, is show in Figure 3. While less than 30 percent of total subjects are unable to walk more than lkm, 65 percent have some difficulty. Between 70 and 100 percent of subjects with degree 1 and 2 severities, excluding visually handicapped subjects, reflect wide differences in walking abilities. However, these differences were not very apparent in trunk-handicapped subjects. The results reveal that the disabled are generally poor at middle and long distance walking even though they can actually walk.

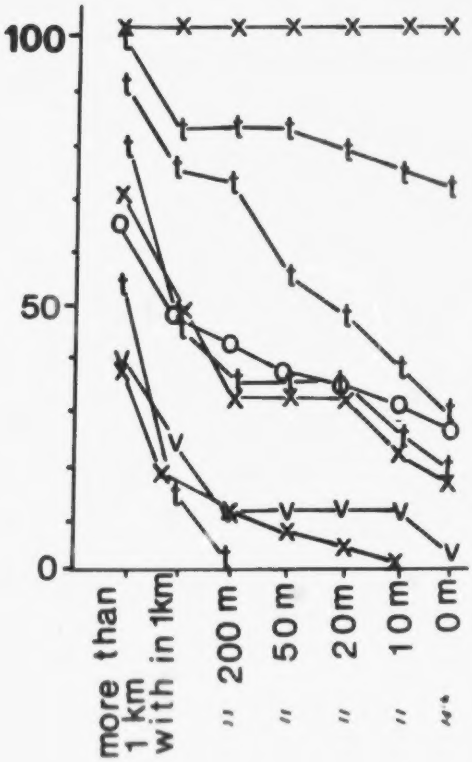


Figure 3

The percentage of subjects with difficulties at certain distances in relation to the type of handicap and the degree of handicap severity

Use of Transportation

Figure 4 shows whether the subjects are able to use various kinds of transport either with, or without assistance. With assistance, subjects using the Yamayuri-go service or using wheelchairs or travelling on foot have almost no difficulty. However, driving cars, riding on buses, trains or taxi still pose difficulties. Without assistance, riding on trains and buses is about 20 percent more difficuit, in each degree of severity, than using other forms of transport. The greater the degree of severity, the greater the difficulty in using transportation without assistance.

Yamayuri-go is a minibus with a lift, in which the disabled can ride in their wheelchairs or stretchers. Machida City started the service in 1972, as a convenient means of transportation for the disabled with walking difficulties living in Machida. To use the service, the eligible users have to make an appointment by the 20th of the previous month. The users can use the service free of charge to make trips within office hours.

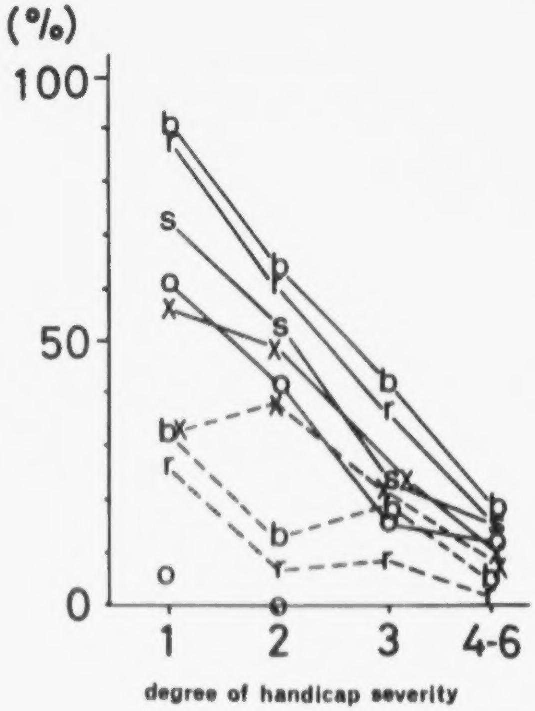


Figure 4

The percentage of subjects who have difficulties in using various kinds of transport either with or without assistance

The results shown above indicate that with assistance severely handicapped people (degrees 1 and 2) are more capable of using transport.

Mobility Restriction Level and Trip Frequency of Disabled Respondents

The mobility restriction level and the severity of handicap, by number of trips, was examined as part of this study.

The number of trips, including all purpose, were counted and converted into numerical values as shown in Table 2.

TABLE 2

Conversion Table For Trip Frequency

	Percent
Almost daily	1.0
3-4 Times per week	.50
1-2 Times per week	.21
1-2 Times per month	.05
Less than once monthly	.02

Vertical Mobility and Trip Frequency

The relation between vertical mobility, such as dealing with staircases at railway station, steps of buses, level differences on roads, and the number of trips made is shown in Figure 5. In general, the results indicate that the lower the mobility restriction level, the greater the number of trips. Subjects who can climb stairs at stations with ease and those who can manage, but with difficulty, go out about 2.6 and 2.3 times respectively more often than those who can not walk.

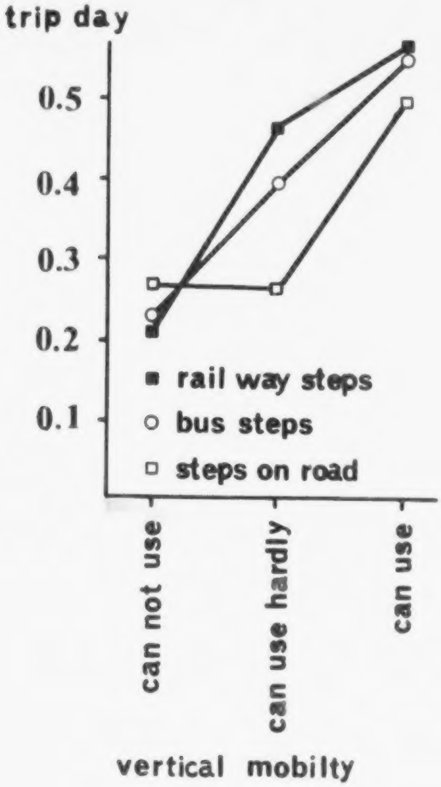


Figure 5

The relation between vertical mobility and the number of trips made

Horizontal Mobility and Trip Frequency

The subjects with a greater walking ability, those who can walk longer distance, obviously go out more often. Those who can walk more than 20km go out about twice as often as those who cannot walk that distance. (see Figure 6)

Transportation Used and Trip Frequency

There is no difference in trip frequency between those who can drive cars and those who cannot. Those who can use transportation by themselves, apart from driv-

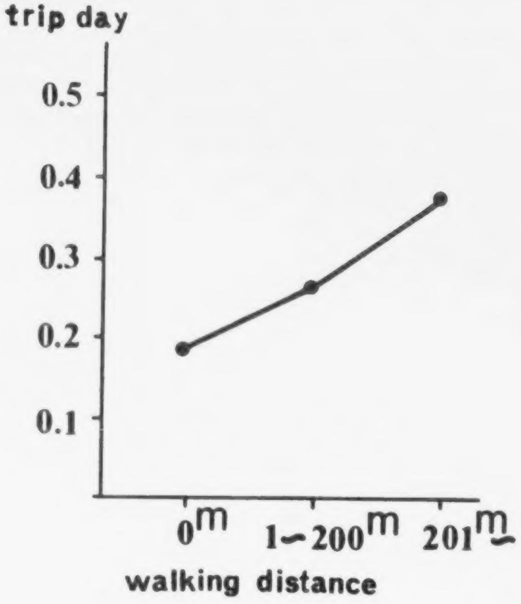


Figure 6

The number of trips made according to mobility restriction level of horizontal mobility

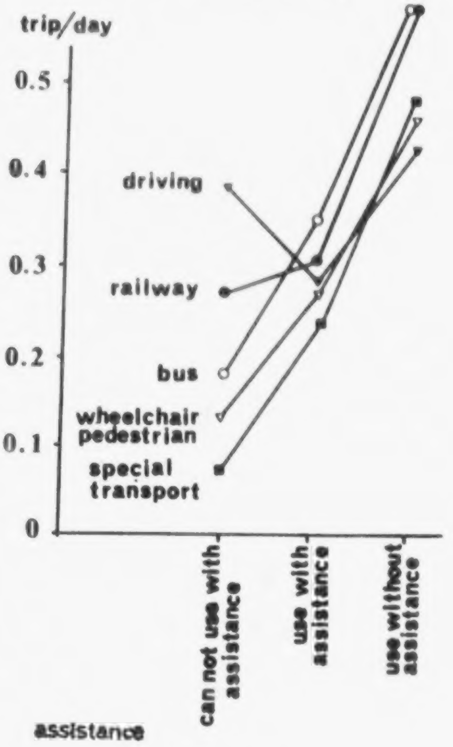


Figure 7

The number of trips made using various kind of transportation either with or without assistance

ing cars, go out between 2 and 5 times more often than those who cannot use transportation, even with assistance. It seems that those who can use transportation without assistance go out quite often, on average 3 to 4 times a week. The trip frequency of those unable to use any kind of transportation, even with assistance, is lowest in the Yamayuri-go users (less than 0.1 times per day), because this group includes those who are ineligible to use the Yamayuri-go service and those who go out only very rarely. (see Figure 7).

Degree of Handicap Severity and Trip Frequency

Those with degrees 4, 5 and 6 go out 4 times a week (0.53 times/day). Those with a severe handicap, degree 1, go out twice a week (0.28 times/day) which is about half a frequently as less handicapped people (degrees 4 to 6). In fact, the trip frequency correlates to the degree of handicap severity. (see Figure 8).

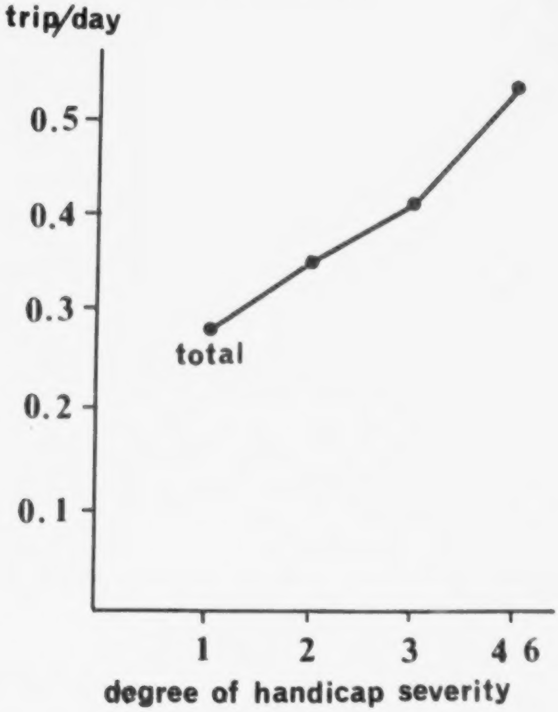


Figure 8

The number of trip made according to degree of handicap severity

Number of Latent Trips

The prior findings show that the more severe the handicap and the harder it is to gain access to transportation, the less frequently the disabled go out.

This study was conducted also to analyze the following two additional points, for the purpose of determining the number of latent trips:

a) the number of desired trips and actual trip frequency.

b) the relation between the degree of handicap severity and the level of mobility restriction on those who gave up going out, and reasons for not doing so.

The Number of Desired Trips and Actual Trips

Table 3 shows the number and the rate of subjects classified by three groups according to the purpose of the trips;

a) those who have made fewer actual trips than desired trips (A◄B)

b) those who have as many actual trips as desired trips (A = B)

c) those who have made more actual trips than desired trips (A►B)

TABLE 3

The Number of Desired and Actual Trips

	A ◄ B		A = B		A ► B	
Trip purpose	*No.*	*percent*	*No.*	*percent*	*No.*	*percent*
Shopping	39	25	109	71	6	4
Medical	23	16	115	79	8	4
Visiting	30	22	100	72	9	6
Leisure	40	36	68	61	4	3
Walking	33	23	97	68	12	8
Welfare	28	24	86	72	5	4
Commuting	3	3	89	94	3	3

A = actual trip, B = desired trip

The results indicate that:

- 60 percent to 70 percent of those who made as many as desired trips for any purpose, excluding commuting and attending school, are satisfied with maintaining the present situation.
- 20 percent to 30 percent of those who have made fewer trips than the number of desired trips, wish to go out more often.

There are very few who wish to go out less often.

Figure 9 shows the number of desired and actual trips according to trip frequency for the purpose of shopping and recreation. For shopping, all those who hardly go out at all and those who go out 3 and 4 times a week, wish to go out more often. Furthermore, in terms of recreation, those who have a low actual trip frequency (no trips less than once a month) wish very strongly to

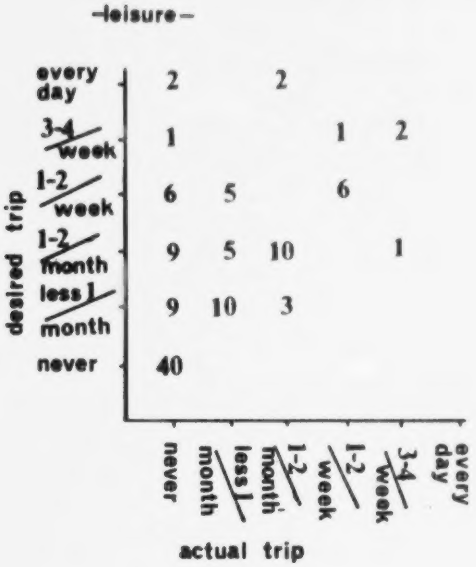


Figure 9a

The number of desired and actual trips

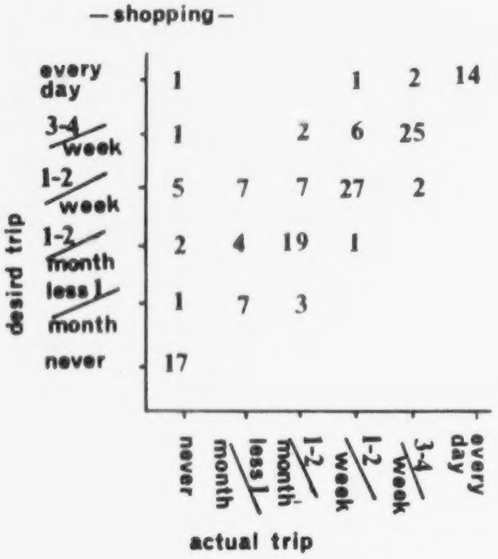


Figure 9b

The number of desired and actual trips

go out. The group wishing to maintain the present situation often go shopping while those who hardly venture out wish to go out for recreation purposes.

Those Who Gave Up Going Out and Their Reasons

Some 137 subjects out of 262 gave up going out (52 percent). Figure 10 breaks down the 137 subjects according to the type of handicap and the degree of handicap severity. The greater the handicap, the more they gave up going out, if not visually handicapped. The reasons are tabulated in Table 4. About half of the subjects listed a restriction on transport such as, its non-availability, lack of assistance, difficult in walking, difference in road levels, problems at entrances and difficulties with parking. The actual handicap itself is directly a reason for less than 30 percent of subjects, who mention they dislike social discrimination, are in poor physical condition , or find going out tiring. In short, about 80 percent of the subjects cited their handicap as a direct or indirect reason for not going out.

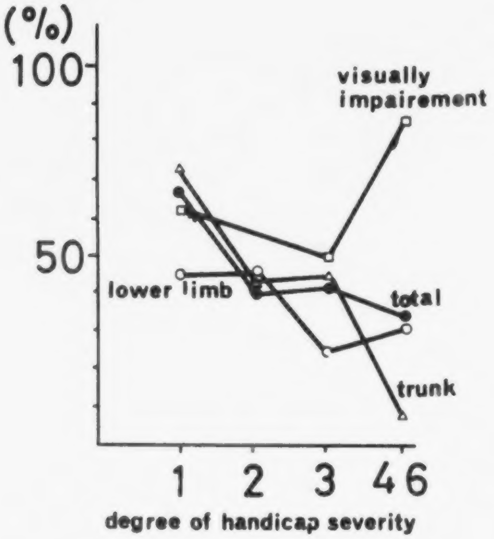


Figure 10

The percentage of those who gave up going out

TABLE 4

Reason For Not Going Out

Reason	*Percent*
Has no transport	18
Has no assistance	18
Difficult in walking	5
Barriers of roads and buildings	5
Inexperience with handicap	2
Unable to park	2
Prejudice	6
Tired and in poor health	20
Poor weather and no money	5
Others	19
Total	**100**

Summary

Mobility Restriction Level and Mobility of the Disabled

a) The degree of handicap severity and the percentage of the disabled who have difficulty in negotiating steps are to some extent correlated. That is, the more severe the degree of handicap, the greater the difficulty. However, in terms of type of handicap, the number of trunk-handicapped subjects having difficulty is greatest, followed by those with limb and visual handicaps.

b) Even slightly handicapped subjects manage with difficulty on staircases, at railway stations, and distance walking more than lkm in distance.

c) With regard to transportation, degree 1 and 2 subjects are governed by whether or not they have assistance.

Use of Transport

a) Regarding vertical mobility, horizontal mobility and in the ability to use transportation, the less the mobility restriction, the greater the trip frequency.

b) The trip frequency of those who cannot walk or who cannot climb up staircases at railway station, is very low.

c) The main factor controlling trip frequency is whether or not it is possible for them to use transportation without assistance.

d) The relation between the degree of handicap severity, which is classified from a medical point of view, and trip frequency, shows that the lighter the handicap, the higher the trip frequency.

Latent Demand

a) Concerning trip frequency, most of the subjects desire to go out as frequently or more often than they do now. Those who rarely go out wish to go out for recreational purpose.

b) Of those who are severlly handicapped and gave up going out more often, about 80 percent gave their handicap as the reason. Those with a lower mobility restriction level gave up going out less often.

c) There is a relation between the number of desired trips and the number of trips given up.

Limitations of this Study

Firstly, this study did not carry out any research on dexterity (ability to grip), speed of motion (ability to board transportation quickly), physical limits (length of time able to stand, or able to walk around in a crowd) or individual property (possession of drivers' license or cars). However, this study did manage to reveal a relation between mobility restriction levels, walking abilities and whether transportation could be used or not.

Secondly, since the sampie size was small a detailed analysis could not be carried out.

Thirdly, although the study document did probe on latent trips, such as the number of desired and relinquished trips and the number of trips which others were asked to perform for them, this area of the study could have been expanded.

References

Hideo Igarashi et.al., "A Plan for a Public Transportation System for the Aged and Disabled." March 1982.

Setagaya Ward Mini Cab Meeting, "Let All of Us Move" The Handicap Symposium. February 1983.

Tetsuo Akiyama, 1983, The 18th. Japan City Planning Congress, Reports of Academic Studies Presentation Meeting. No date.

Tetsuo Akiyama, Research Associate, Department of Civil Engineering, Tokyo Meropolitan University, Tokyo, Japan, 158.

UNDERLYING FACTORS IN THE DEVELOPMENT OF DEMAND RESPONSIVE TRANSPORT IN BRITAIN

J.M. Bailey

Introduction

Improvements to mobility opportunities and transport for elderly and disabled people in the U.K. have generally concentrated on income support (i.e. the mobility allowance) for the most severely disabled, concessionary bus fares for the elderly and the provision of transport services for medical care, day care and social rehabilitation for both groups (see Garden 1979). The voluntary sector has specialized in transport for organized activities and, to a much smaller extent, for personal travel needs. (Bailey 1979).

Non-car-owning, low-income elderly and disabled people, not receiving mobility allowance and unable to use public transport, have generally been left with no means of travel for personal journeys. Mobility allowance beneficiaries who are too disabled to travel by car or taxi, have also found that specialist services for personal travel simply do not exist, even if they are prepared to pay for them. Over the last four years there has been a sudden and appreciable upsurge in the provision of transport to fill this important gap.

Exact figures on the nature and growth of transport schemes are difficult to come by as there is no all embracing directory, and certainly no statistical evidence at the national level. (A national Advisory Unit has been set up to monitor progress and develop expertise, so more comprehensive information will probably become available in due course). Moreover, there is no standard pattern of operation and organizational structure, and this leads to difficulties in classifying schemes. Various information sources were therefore used to compile a list of seventeen demand responsive services which could be studied in more detail. The seventeen were selected to provide a good cross section of service types and organizations, but they cannot be taken as necessarily representative of all schemes in existence.

A tape recorded interview was conducted with each organizer and any available data was collected. The full results of this survey are recorded elsewhere (Bailey and Appleby 1983). They also form the basis of this paper, but further, more extensive and detailed surveys are being carried out as part of a larger study.

Figure 1 shows the period over which each of seventeen schemes have been operating (it also includes the Reading scheme which was part of a separate study, Heraty 1984). Note the recent growth in services, particularly after 1981.

The aim of this paper is to explain some of the factors underlying these recent trends. Why and how has the growth come about?

The paper is divided into sections as follows:

(i) the role of the voluntary sector,
(ii) the availability of funds,
(iii) legislative changes,
(iv) discussion and assessment,
(v) summary and conclusions

The role of the voluntary sector

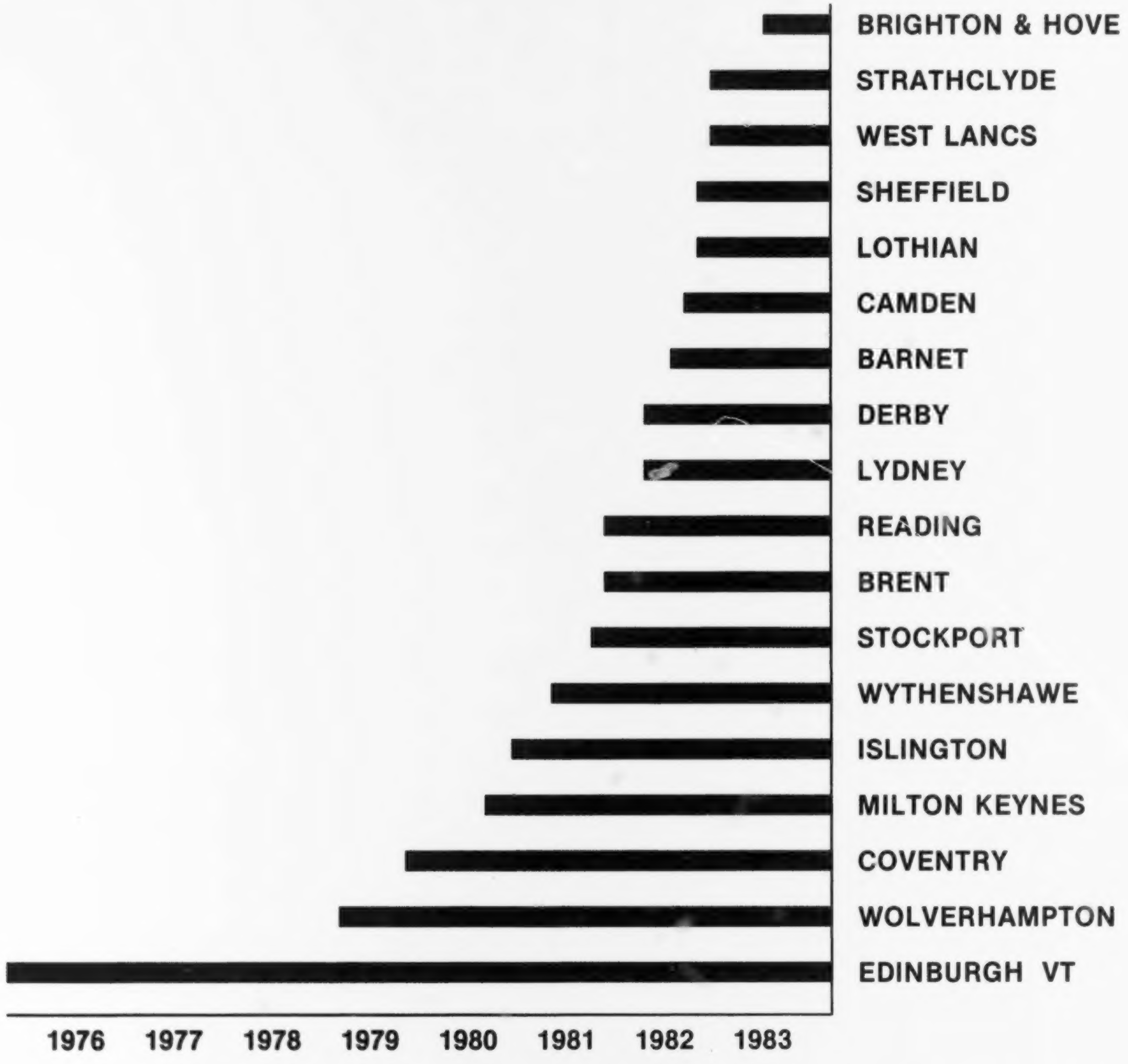
The term 'voluntary sector' is not necessarily synonymous with 'volunteers'. A voluntary organization is essentially a non-profit organization which determines its own policies. This often means that it employs professional paid staff in addition to volunteers. Moreover, the scope of the voluntary sector comprises many different groups, for example: interest and pressure groups at national levels; direct providers of services (e.g. transport), social and welfare groups at local levels; and self-help community groups. As one would expect therefore, the issue of improving transport and mobility for disabled people has been taken up in different ways by different groups.

National pressure groups in Britain certainly contributed to the emergence of the Mobility Allowance, disabled persons car scheme (Motability), parking concessions and other developments, but have probably not been as vociferous as their US counterparts on issues of public transport. Developments at the local level have been much more significant in Britain.

During the 1970s there was a substantial growth in the number of social and community groups concerned with elderly and disabled people (Hatch 1980). Their role in providing social clubs, outings and meals at centres, for example, inevitably led them into the area of transport provision (Bailey 1979). Many groups began to organize volunteer drivers, using their own cars to bring people to meetings. Others purchased their own mini-buses. A whole new movement called 'community transport' began to grow up around these services. The national organization, Community Transport, was set up specifically to coordinate these groups and provide transport services for such activities. It currently operates local schemes in seven cities.

FIGURE 1

Dial-a-Ride for Disabled People: Some Schemes Currently Operating



In rural areas a different form of community transport also began to grow. This was primarily to provide a substitute for declining public transport services. Again volunteer car drivers, or minibuses driven by volunteers were used, in some cases providing regular scheduled services. As Bell (1983) has stated, the community transport concept itself is therefore somewhat confusing. However, it was mainly the urban-based movement which took on the role of campaigning for better transport for disabled people. A number of studies carried out during the late 1970s (e.g. Norman 1977, Bailey 1979 and Spastics Society 1979) identified the gaps in the provision for personal travel needs, which the community transport movement seized on, as both the campaigner and provider of services.

The essential element of the new approach to travel needs being adopted by the community transport movement was its liberating potential: i.e. the basic philosophy of individual freedom of choice with the minimum of constraints. This contrasts strongly with previous practice in the provision of voluntary transport which sought to meet only 'urgent' and 'pressing' needs and to provide transport only after a careful vetting of the case.

By 1980 a few demand responsive door-to-door services were operating, namely in Edinburgh, Manchester, Milton Keynes, Coventry and Islington (London). They generally used one or two small vehicles capable of carrying a passenger in a wheelchair and one other, and operated like a private hire car. Interestingly, the two latter schemes were operated directly by local municipal authorities. In the Coventry case only an off-peak service was provided. This scheme in fact used two 13-24 seat buses with the important secondary objective of utilizing such vehicles at a time when they would otherwise be standing idle.

Most of these schemes, and many subsequent ones, have identified with the name 'dial-a-ride'. This concept originated in the early 1970s (Oxley 1970) as a new type of demand responsive public transport serice using small, radio controlled vehicles. At the time it was operated by bus companies as a means of serving sparsely populated areas with low levels of public transport demand, providing services in more densely populated areas at off-peak times and offering better quality public transport which might attract car users. Dial-a-ride schemes of the 1970s could not be justified on economic grounds and failed because they did not provide good value for money at a time of financial cut backs. Their potential as a form of specialist transport for elderly and disabled people was not therefore exploited at the time (see Bailey 1984).

Whilst it is probably true to say that the schemes of the early 1980s grew out of the dial-a-ride idea, they operate much more like a taxi (i.e. providing exclusive ride service based on a charge for the vehicle) rather than a bus (i.e. allowing shared rides and charging separate fares). Primarily this reflects the philosophy of many schemes to provide a high quality personal service with the minimum of restrictions (i.e. no zoning or routeing). The ability for voluntary and social organizations to charge separate fares outside the public transport legislation was granted in 1977. They did not therefore have to face the same controls as the earlier dial-a-rides. The main reason why services began to develop when they did was the availability of funds. Much of the growth in funds was from government sources, as we shall see in the next section.

A secondary, but none the less important reason for the recent growth, was the International Year of Disabled People (IYDP) in 1981. This provided a new focus of interest, nationally and locally, on the needs of disabled people. Many local groups wanted to do something different that would be helpful and useful and at the same time identifiable as an IYDP initiative. Improving transport was an obvious candidate.

The availability of funds

Up until the late 1970s at least, the primary source of funds for voluntary organizations has been shown by a number of surveys (e.g. Johnson 1978, Bailey 1979) to be donations and fund raising schemes. The latter include collections, raffles and other special events. There is also evidence of grant aid support from local authorities, but the development of the organization has often depended heavily on the skills and enthusiasm of the volunteers in a regime of very limited resources.

An essential element of volunteer input is its part time nature. Volunteers cannot be expected to work the same hours as paid staff. Therefore the all-day-seven-days-a week service envisaged by the new dial-a-ride schemes posed a significant dilemma for traditional methods of staffing. Such a service could only be provided on a voluntary basis if the number of staff is increased dramatically. But this was likely to result in severe management as well as recruitment problems. There was, therefore, little alternative but to employ at least some paid staff.

This need for paid staff immediately posed a severe financial constraint on the development of services. The schemes which had developed during the late 1970s represented something of a breakthrough in funding. The two main sources of funds were: (i) the government's Urban Programme, (ii) special initiatives from local municipal authorities.

Although set up in 1969 to provide funds for urban areas suffering from economic, environmental and social problems, the Urban Programme had not been a major source of funds for voluntary organizations providing transport until the late 1970s. Grants to voluntary organizations under the Urban Programme totalled about 43m pounds Sterling in 1982 / 3. They have been growing at an annual average rate of about 45 per cent over the 3 years prior to this (NCVO 1983).

Grants are awarded on the basis of a 75 per cent share from central government and 25 per cent from the local authority. There is thus a two-stage vetting process except for local authorities themselves who are also eligible for grants The two local authority schemes in Coventry and Islington (London) are in fact funded on this basis. Grants are relatively long term, up to five years and can include all revenue and capital items.

The New Town Development Corporation and local authority at Milton Keynes were the main sources of funds for the project which developed there (see

Lightfoot, 1981). This was more the exception than the rule. However, recent involvement by the Greater London Council has been very significant. In a major initiative in 1982 they set aside 600,000 pounds Sterling to finance experimental transport schemes for disabled people over the subsequent three years. By July 1984 they are committed to funding eleven dial-a-ride schemes and to implementing a user side subsidy scheme for the whole of Greater London at a cost of 1.1m pounds Sterling . London boroughs such as Camden and Islington are also getting involved in funding as are the metropolitan counties in the rest of the country.

Apart from the growth in sources of funds which already existed in the early 1970s, other new and important sources have emerged. Primarily these related to the rising tide of unemployment and are intended to finance job creating schemes for school leavers and the longer term unemployed. Such funds are available from the Manpower Services Commission (MSC) of the Department of Employment.

The main programmes are:

(i) the Youth Training Scheme. This was originally introduced as the Youth Opportunities Scheme in 1978 and aimed at providing work experienoe and training for unemployed school leavers for up to a year. During the early 1980s, about 500,000 placements were being provided annually on this scheme.

(ii) The Community Programme (CP). This was introduced in 1982 with the aim of providing 130,000 places for people aged 18 and over who have been unemployed for at least 12 of the previous 15 months. It similarly offers employment for a maximum of 12 months. The introduction of the CP represented a major effort to provide four times the number of places compared to previous MSC schemes which had operated from 1978. However this was mainly to be achieved by a shift from full time to part time staff. The MSC agree to pay a maximum of 60 per week per place. The exact hourly rate for the job was to be agreed upon locally. Thus a full time worker (say 40 hours per week) would have received only 1.50 pounds Sterling per hour. Current rates for drivers are probably about 2 pounds per hour.

Apart from the restrictions on employed staff, the big disadvantage for dial-a-ride operators funded by the MSC is the limitation to one year's employment. This is obviously detrimental to building up a good teamwork approach, commitment to the service, and a relationship of trust and reliability between drivers and passengers. The one year rule applies not only to staff but to the overall funding of the scheme as well. Although a scheme grant can be extended, as many have been, they must employ new staff who meet the MSC conditions.

The growth in unemployment has led also to the provision of funds to support volunteers (i.e. meeting the costs of overheads, materials, etc.). There are two main sources:

(i) The Department of Health and Social Security (DHSS), Opportunities for Volunteering fund.

(ii) The Manpower Services Commission, Voluntary Projects Programme.

The DHSS scheme is limited to work in the health and social services fields. the MCS scheme, has a wider brief, but is limited to unemployed people and provides only one year's (voluntary) work. Neither scheme would of course provide the primary source of funds for dial-a-ride, but they could and have provided useful supplementary funding. Many schemes do in fact utilize a variety of different funding sources as Figure 2 shows.

FIGURE 2

Main Source of Funds for Schemes Studied

	Urban Programme	*MSC*	*Local Authority*	*Govt. Funding for Volunteers*	*Private Sources Donation*
Barnet				•	•
Brent	•				
Brighton		•	•		•
Camden			•		
Coventry	•		•		
Derby	•	•			
Edinburgh Vol. Trans.			•		
Islington	•		•		
Lothian		•			•
Lydney					•
Milton Keynes		•	•		
Reading	•		•		
Sheffield	•	•			
Stockport		•	•		
Strathclyde	•				
West Lancs		•			
Wolverhampton	•				

Legislative changes

Recent legislative changes have influenced the growth of dial-a-ride in two related respects: the quantity and quality control conditions relating to service characteristics, vehicles and staff. Prior to 1977 there was no legal basis on which individuals could be charged separate fares for the transport service, other than the Public Service Vehicle (PSV) regulations which governed the operation of buses and coaches. After much pressure from voluntary organisations (see NCSS 1977) a Private Members Bill went through Parliament becoming the Minibus Act 1977. It enables organizations concerned with education, religion, social welfare or other activities for the benefit of the community to charge separate fares, provided they did not carry the public at large, but rather their own members or clients.

Many of the strict conditions on vehicle safety, e.g. vehicle maintenance and emergency exits, still apply, but conditions of comfort, such as set spacing and headroom, have been relaxed. A system of permits was set up under the Act. This has subsequently been consolidated into the Public Passenger Vehicles Act 1981.

A number of voluntary organizations, local authorities and other bodies were designated in 1980 as being allowed to issue permits in addition to the main public transport licensing body, the Traffic Commissioners. Once issued, permits stay in force unless revoked. However, each new vehicle requires a separate permit. The number of permits issued is currently running at about 2000 per year (Department of Transport 1983). They include all passenger transport services provided for social and welfare purposes, of which dial-a-ride comprises an unknown, but probably small part. The legislation on permits, applies to vehicles with 8 or more passenger seats. Subsequent legislation allowing separate fares to be charged in smaller vehicles was incorporated in the Transport Act 1978.

This allows payments for car sharing as a contribution to running costs. There are no restrictions on journey purposes or groups of people involved, but services operating commercially are excluded and there must be no element of contribution in addition to running costs. Commercial taxi and hire car schemes can be organized by local authorities and are then allowed to advertise.

Discussion and assessment

The important question to be addressed in this section is the combined effect of the factors discussed on the nature of the transport services which have emerged. UK schemes, in general, are smaller (in terms of numbers of vehicles) than their U.S. counterparts and operate over a larger surface area (see Figure 3). Many organizers have argued that demand has rapidly outstripped the available resources. There is some evidence of a rapid growth in demand for new services (e.g. West Lancashire and Stockport) and even the older schemes (such as Islington and Edinburgh) are still experiencing some growth (see Figure 4). However the level of trips/vehicle/month for UK schemes is still very much below that for comparable U.S. schemes. This suggests that, in general, there is scope for further expansion. In fact the objective of providing a service with the minimum of restrictions on users has lead many voluntary organizations into a stituation where their available capacity is being very poorly utilized. Some schemes allow individuals to reserve the vehicle for long journeys and/or to await a return. Given the equally important objective to provide a widely available service, current practice to overcome this problem has been to restrict the number of advance bookings held by an individual at any one time and the maximum period in which advance bookings can be made. The consequences of this policy can be profound, for example:

FIGURE 3

Area Coverage of Selected U.K. and U.S.A. Schemes

	No. of Vehicles	*Vehicles/ 100 sq. km.*	*Trips/ Vehicles month*	*Average cost per trip*
U.S.A. Schemes				($)
Rochester	8	1.46	625	7.64
Naugatuck	15	16.64	633	8.40
Portland	11	7.35	670	7.31
Westport	5	14.12	340	—
New York City (Easyride)	10	310.56	423	10.83
Proviso Township	2	4.29	555	5.88
Will County	6	0.44	423	5.50
			MEAN 524	MEAN 7.59
U.K. Schemes			(1)	pounds
Camden	6	27.62	—	—
Milton Keynes	1	0.32	272	10.78
Edinburgh	2	0.75	88	9.44
Lothian	6	0.34	66	16.16
Stockport	2	0.16	164	3.26
West Lancs.	1	3.06	236(2)	6.99
Barnet	1	1.12	23	7.53
Coventry	2	2.07	237	5.06
Islington	2	13.44	300	4.70
Derby	2	2.56	217	5.19
Wolverhampton	1	1.45	150	4.32
			MEAN 175	MEAN 7.34

SOURCES: US: Spear et al (1981); Middendorf et al, (1983)
UK: new surveys as part of this study.

Notes: (1) Changes in Vehicle fleet size over the period surveyed are taken into account. Passenger figures exclude escorts.
(2) Passenger figures include escorts.

(i) Regular bookings for work, education and shopping trips cannot be accepted, leaving a major gap in service provision.

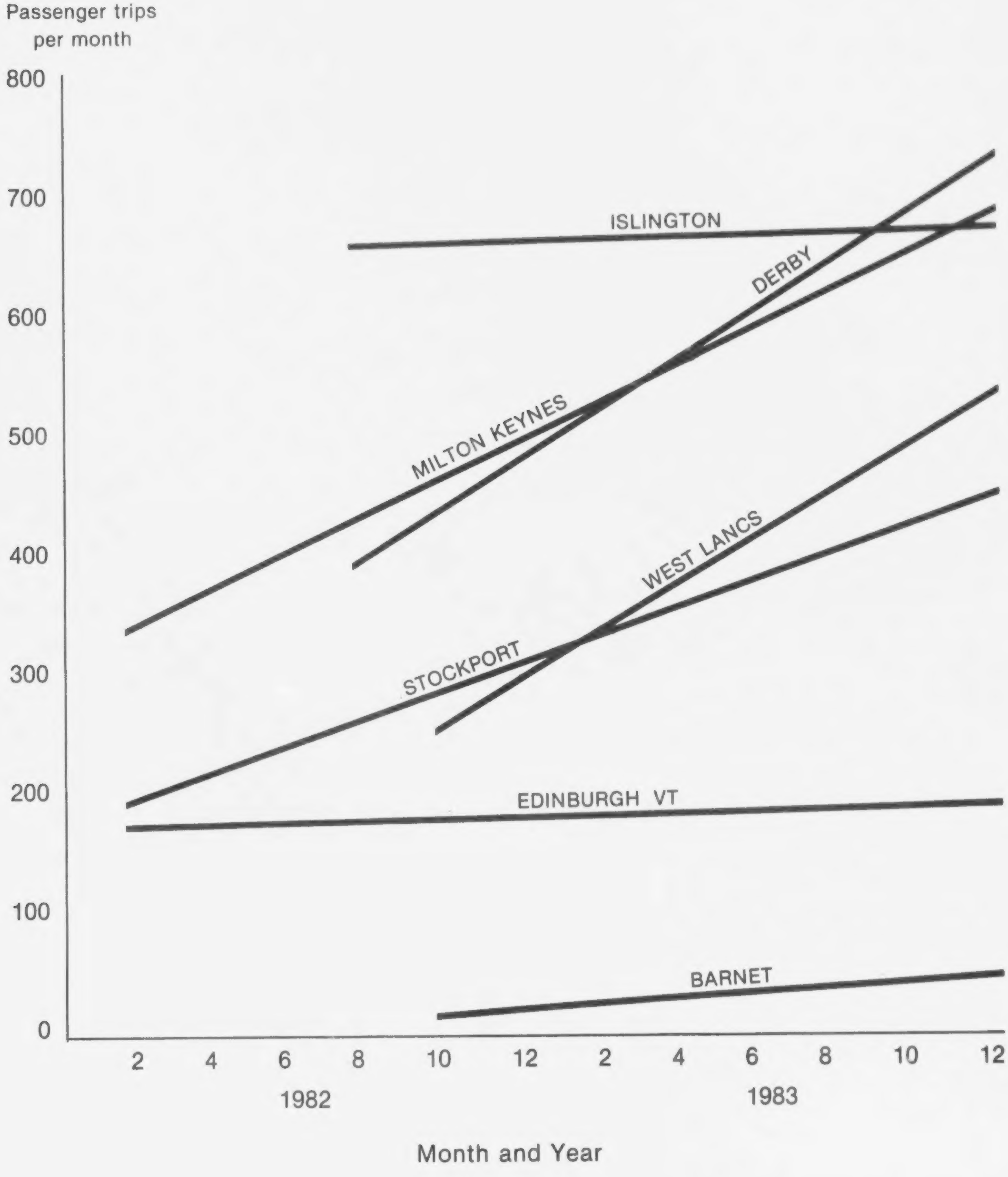
(ii) Each journey requires considerable planning and booking well in advance. Although prepared to accept last minute bookings, few schemes appear to be in a position to do so in practice. Indeed the difficulties of making a booking (trying to get through on the telephone and then obtain the time you want) have been a major problem highlighted in recent surveys (Bowlby, Kirby and Swann 1984; Bailey and Appleby 1983).

(iii) Travelling independently represents something completely new for many potential users. Such a major change in lifestyle often requires considerable forethought and psychological preparation. Many schemes have emphasized in their publicity the need to raise the travel expectations of users. The confidence of the user can therefore rapidly diminish again if his travel expectations are immediately dashed as a result of booking difficulties.

FIGURE 4

Growth In Passengers 1982—1983 (UK SCHEMES)

(Estimated ordinary least squares regression lines)



Possible alternative courses of action which have generally not been followed are:

(i) Identify the main corridors of travel and attempt to cater to these by a more structured service operating in specific areas at specific times of day. Limited services of this type do now in fact operate. It may also be possible to allow hail and stop facilities, if vehicle capacity allows, to avoid the need for booking at all. In theory this would reduce the availability of service to any one area but would probably make it easier to book in practice. Moreover, it would still be possible to provide completely unstructured many-to-many services at off peak times.

(ii) Increase the level of resources available to each scheme. There are obvious financial barriers to doing this.

(iii) Adopt a revised charging structure to limit demand to available capacity, discriminating between particular groups of users if so desired. Charges and charging structure do not appear to have been used very much as a means of influencing demand. In many schemes charges have been set more with a view to achieving equity between users; some involve quite complex elements of mileage rates, fixed charges, time based charges and zonal fares. Even though fares appear to differ markedly between schemes (Bailey and Appleby 1983) the level of subsidy is generally in excess of 75 percent and more commonly around 90 percent.

The extent to which services are meeting needs in a cost effective manner has been somewhat obscured by the social policy and employment creating objectives of the bodies providing funds. There is no mechanism for evaluating value for money as a transport service per se, nor any specific policy on meeting needs. Academic or not, the needs question is one which we will be addressing in our subsequent research. But cost effectiveness, at least in terms of a comparison with U.S. schemes, can be broadly assessed from Figure 3. The average cost figures are given in dollars for the U.S. and pounds for the UK, so readers can make their own assumptions about exchange rates. The mean for the UK schemes appears to be higher than the equivalent figure for the US, with a somewhat greater dispersion in the UK case. Much more evidence is required on this, particularly to allow a comparison between special transport, user side subsidies and accessible public transport.

Given the growth in the numbers of paid staff, a final important issue to be considered is that of the role of paid staff in a voluntary organization and their relationship to volunteers. This is not a new issue, but has grown in importance with the increased emphasis on paid staff employed by voluntary organizations. In essence the organizational and managerial requirements within a voluntary organization are likely to be similar to those required in the public and private sectors, but its underlying philosophy of caring and democratic control can result in staff management difficulties. As two organizers have put it:

"It is expected that staff roles will overlap and that decision making will be shared. This structure can make a teamwork approach difficult as the co-ordinator is at one time both directing and sharing decision making,"

"Everyone's post is not so well defined as in the commercial sector and the hierarchies aren't defined."

Such difficulties are exacerbated in voluntary organizations employing both paid staff and volunteers. The problems here relate similarly to role difinitions and positions in the hierarchy. For example, the volunteer may not consider himself part of the same hierarchy as the paid staff and, therefore, not subject to the same management control, constraints on working hours and individual responsibility for the work he undertakes.

Summary and Conclusions

The voluntary sector has been paramount in providing the enthusiasm and motivation for the recent developments in local transport schemes. However, the sudden take off in the 1980s reflects the greatly increased availability of funds, the much freer legal regime and the special interest generated by the International Year of Disabled People (1981).

For many schemes funding still remains somewhat insecure. Funds appear to be allocated according to criteria outside the control, and often even the influence, of scheme organizers. These criteria may change at short notice in response to changes in the broader objectives of social policy. Schemes funded by the Manpower Services Commission have to face, in addition, frequent staff changes which have a severe debilitating effect on the service. This has repercussions on the staff / passenger relationship and on the quality of service offered as well as the general organizational stability of the scheme.

Many schemes now face problems related to booking difficulties, which appear to be mainly a consequence of their failure to reconcile two conflicting objectives, namely, maximize both the number of users and the number of journeys per user. There is clearly a need for a much more careful consideration by organizers, of the alternative operational characteristics and constraints open to them and the effects of these on users.

The management and organization of some schemes has become more complex because of the increasing number of paid staff within a voluntary organization, and even more so where these staff work alongside volunteers. It is early days yet to see how significant this is likely to be, but the problems are likely to increase with the average size of schemes. At the moment most schemes are fairly small. Their financial horizons are also very short.

The idea of dial-a-ride as the key to liberation and freedom of movement for disabled people, which seems to have emerged from the 1970s, has overshadowed to some extent the need to consider the practical issues involved. The development of dial-a-ride has also taken place well in advance of a consideration of the wider issues such as cost effectiveness in the light of alternatives and an appropriate basis for funding. Taxis accessible to wheelchair users, user-side subsidies and improved access to public transport are all beginning to develop alongside dial a-ride. Undoutedly these are issues which will have to be faced in the future. However, it is perhaps entirely appropriate that the voluntary sector should be concerned with introducing services where nothing at all existed before and articulating, the now very evident demands of disabled people, for some form of special transport.

Acknowledgement

The work described in this paper forms part of the programme of the Transport and Road Research Laboratory and is published by permission of the Director.

References

Bailey J.M. (1979), Voluntary and Social Services Transport in Birmingham, Redditch and Bromsgrove, Transport and Road Research Laboratory Supplementary Report 467.

Bailey J.M. And L. Appleby (1983), Recent Developments in Special Transport for Disabled People, Oxford University Transport Studies Unit Working Paper ref: 239.

Bailey J.M. (1984), Is there a Role for Dial a-Ride in Britain?, PTRC Summer Annual Meeting.

Bell W.G. (1983), Mobilizing Volunteers in Community Transport for Elderly and Handicapped in Great Britain, Specialized Transportation Planning and Practice Vol. 1 No. 3.

Bowlby, S.R., A.M. Kirby and V. Swann (1983), Special Transport for the Disabled in Reading, Transport and Road Research Laboratory, Supplementary Report, forthcoming.

Department of Transport (1983), Annual Reports of the Traffic Commissioners, Department of Transport.

Garden J. (1979), The Mobility of the Elderly and Disabled on Britain: An Overview, In: Ashford and Bell eds, Mobility for the Elderly and Handicapped, Loughborough University of Technology.

Hatch S. (1980), Outside the State: Voluntary Organizations in Three English Towns, Croom Helm.

Heraty M. (1984), Monitoring Demand Responsive Transport for Disabled People: The Readibus Example, Transport and Road Research Laboratory, Supplementary Report 828.

Johnson E. (1978), The Finance of Voluntary Organizations for the Physically Disabled. Social and Economic Administration Vol. 12 No. 3.

Lightfoot G. (1981), Community Initiatives and Coordination, In: Ashford, Bell and Rich eds, Mobility and Transport for Elderly and Handicapped Persons. Gordon and Breach.

Middendorf D.F. et al (1983), Cost Effectiveness of Transportation Services for Handicapped Persons, U.S. Transportation Research Board (NCHR program report 261).

National Council for Social Service (NCSS) (1977), A Fair Deal for Minibuses, NCSS.

National Council for Voluntary Organization (NCVO) (1983), Government. Grants: A Guide for Voluntary Organizations, Bedford Square Press.

Norman A. (1977), Transport and the Elderly, National Corporation for the Care of Old People.

Oxley P. (1970), Dial-a-Ride: Demand Actuated Public Transport, Traffic Engineering and Control.

Spastics Society Working Party (1979), Can I Get There?, Spastics Society North West Region.

Spear B.D. et al (1981), Service and Methods Demonstrations Program Report, U.S. Department of Transportation (UMTA).

John M. Bailey, Transport Studies Unit, Oxford University, Oxford, England, OX2 6NB.

SPACIAL DESIGN TECHNIQUE FOR USERS OF WHEELCHAIRS AND OTHER MOBILITY AIDS

John H. Balls

Introduction

The spacial design techique is a method of determining the three dimensional space needs of disabled persons when the size and functional characteristics of mobility aids are a significant factor in design.

This paper describes spacial design for a four wheeled chair and user and in particular, a manually operated adult size wheel chair with a pair of castered wheels at the front and a pair of large wheels with propelling rings at the rear.

This spacial design technique applies equally to a consideration of other types of mobility aid either for the special needs of individual users or of groups of users.

A consideration of the basic design problems is followed by the research aims and problem solutions. A description of the developed technique is followed by examples of how this design method has been used to solve both simple and complex space design problems that could not be solved using traditional design methods.

The Design Problems

It has been found that works produced according to existing codes and standard practices do not always meet the needs of the disabled persons for whom the facilities are intended.

It has also been found that codes and practices often do not cover situations found in practice particulars when modifying existing buildings or where economy in costs and use of space is of major importance or where the needs of particular individuals or selected groups of individuals must be met.

Design recommendations by the United States, the United Kingdom, Australia and other countries are at times in conflict and generally lack information on the size and type of user, mobility aid and the access manoeuvres on which the recommendations are based.

Available codes and practices on space requirements generally state the minimum or maximum allowed in design without information on the relationships between variables which data would permit flexibility in design and could result in more economic and useful facilities for disabled persons.

It appears clear that past training and experience in architecture, engineering and related professions and the use of available codes and practices is not sufficient to ensure good design in the field of access for disabled persons.

It seems essential for designers to have also a good understanding of disabled people, their abilities, the aids they use, the manoeuvres they need to perform, the range of sizes and the degrees of skill in mobility involved.

There seems also a need for methods of design that take account of the many site variables involved and that yield good designs of modified or new facilities that are safe and useable by the persons for whom intended

It is to these ends that research into spacial design was directed.

Research Aims

The basic aims of the research were to provide:

a. A desk method of detemining design layouts and spacial dimensions.

b. A method of making sound spacial decisions based on real people and equipment but that does not require subsequent field testing of each situation studied to establish suitability.

c. A method that can be repeated and yield the same result and that can be checked by others.

d. A method that takes into account the physical size and skill and manoeuvres performed by individuals or groups of disabled persons.

e. A method that allows a study of variables and that can show the relationship of various spacial dimensions.

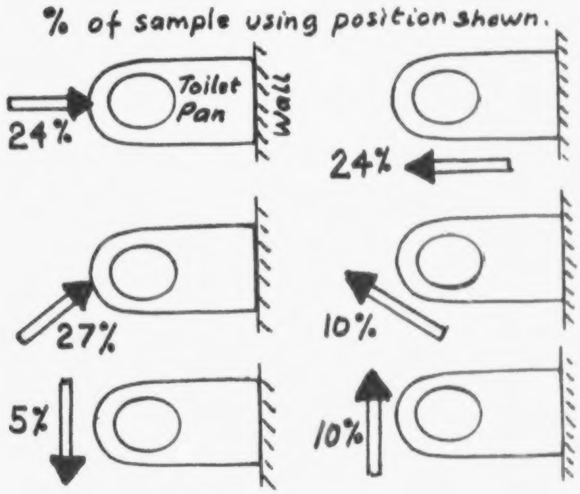
f. A method that is easy to use, is adaptable and that does not involve the use of bulky, or elaborate equipment.

Research Method

Data on disabled persons, mobility aids, manner of use, skill in use and spacial needs were obtained during the field testing by approximately 250 disabled persons in a wide range of access facilities that included carparks, office areas, water closets, showers, bathrooms, lifts, passages and doorways. Of some 300 wheelchairs examined, 79 were measured to determine the range and distribution of key dimensions that affected spacial needs. These data were used to develop a method of calculating user error, wheel chair size and space needs.

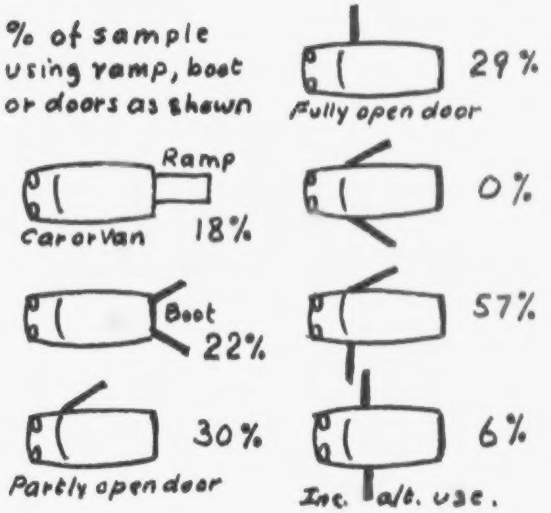
a. Manner of use of Wheel Chairs. Records were kept during field testing of the manoeuvres people used and the final positions of their wheel chairs when they used various facilities such as vehicles, toilets (water closets), basins (lavatories), baths and door levers.

From these data common manoeuvres and common chair positions were determined together with the number and hence the percent of sample that used a particular manoeuvre of chair position. Example of these data are included in Figures 1 and 2.



Wheel Chair positions for transfer to toilet pan.

FIGURE 1

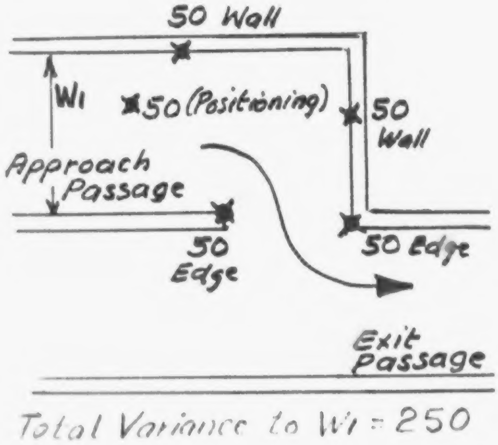


Use of and amount car doors need to be open

FIGURE 2

Manoeuvre		Variance
Stopping forward		25
Stopping backwards		50
Side positioning near wall		50
Clearing an obstruction		50
Single Loop	Ahead -	25
	To side -	50
Double Loop	Ahead -	50
	To side -	75
Triple Loop	Ahead -	75
	To side -	100

Rules for Variance
FIGURE 3



Example of Applied Variance
FIGURE 4

b. Skill in Use of Wheel Chairs. Dimensional details of mobility aids and the least space needed by each person to obtain access were recorded during tests. Thus it was possible to reproduce to scale the key dimensional details of the wheel chair used by a particular subject and to find by trial and error, using a scale drawing of the situation or layout tests, the minimum space in which that person could have achieved access, had perfect control of the wheel chair been possible.

The difference between actual space needed and the mimimum required with perfect control of the same wheel chair was called variance and taken to be a measure of that person's skill in use in that particular situation.

It was found that, when in a limited space, most wheel chair users could achieve an accuracy of about 50 mm when positioning their wheel chair. Some persons could position very quickly, others were slow to position and some made a series of minor adjustments when positioning carefully.

It was also found that variance increased rapidly as the number of walls, door frames or other objects that had to be avoided, increased.

From this information a set of rules were developed for desk determination of variance for various access situations that when applied to the cases field tested gave a reliable value for real people.

These rules for variance are shown in Figure 3 and an example of the use of the rules is shown in Figure 4.

c. *Wheel Chair Dimensions*. It was found that certain diagonal dimensions of wheel chairs were in many cases more important to spacial design than the overall length or width.

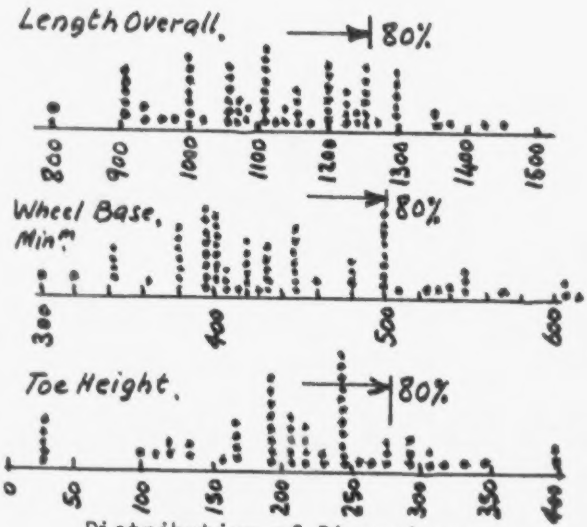
The horizontal diagonal length from the ground contact point of a rear wheel to the front opposite corner of the foot rest was particularly significant as was also the horizontal length from the rearmost part of a rear wheel to the front opposite corner of the foot rest.

These vital dimensions are automatically taken into account by use of correctly wheeled ground level silhouette of a particular wheel chair or of one that represents a particular group or percentage of wheel chairs in use.

Our general design concern with respect to a particular task of reviewing the Australian Standard AS 1428 was to arrive at spacial dimensions that would allow access for a reasonable number of wheel chair users. To provide "convenient to use" space in public places for every wheel chair used was seen as both spacially and economically impossible at the present time.

Characteristic	Dimension
Length overall	1250
Wheel base	500
Width overall (include a total of 80 for knuckle clearance)	740
Toe Height	280
Large Wheel dia	620
Knee height	660
Arm rest to end of toe	500
Waist to end of toe etc	700

Dimensions of A80 Wheel Chair
FIGURE 5



Distribution of Dimensions
FIGURE 6

It was decided that access for 80 percent of known wheel chair users was at this stage an acceptable target and that the need to make up to three looping movements for lateral shift of the rear wheels during entrance and again during exit from a confined area, such as a toilet cubicle, was acceptable.

These decisions in effect established design data for facilities easily useable by 80 percent of wheel chair users. Of the remaining 20 percent some would be able to obtain access with extra effort and or difficulty; some would need assistance and a few could find access impossible.

The A80 (Adults 80 percent) wheel chair required for design on this agreed basis was developed as follows:

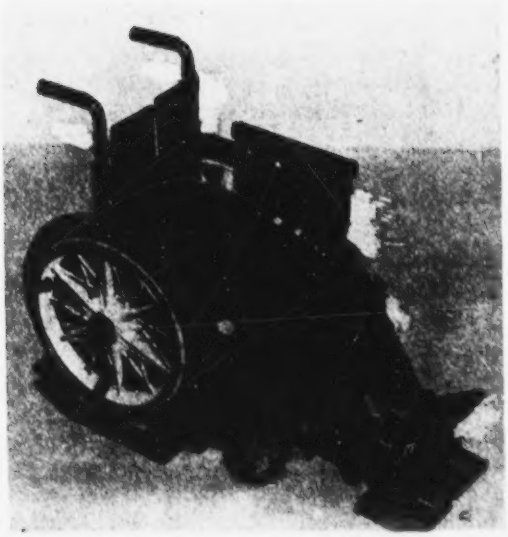
1) From a survey of about 300 in-use wheel chairs 79 were selected as representative of the range and types that needed to be considered.

2) All spacially important dimensions of these 79 wheel chairs were measured.

3) The range and distribution of each of the measured dimensions were plotted and the derived dimensions that, from the point of view of space needs, included 80 percent of the chairs studied were selected as the dimensions to be used for the A80 wheel chair. From these basic data other dimensions can be obtained that include or exclude selected percentages of the sample.

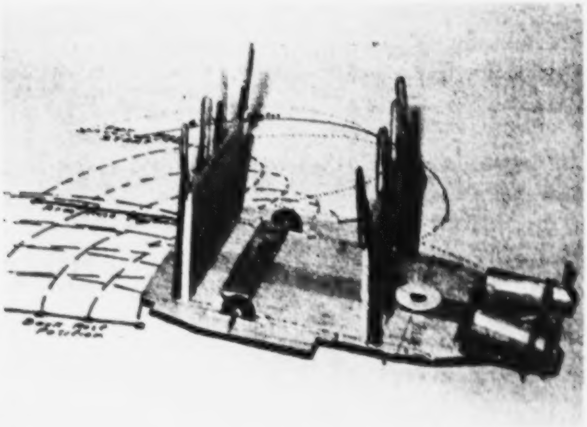
4) Typical derived values for the A80 wheel chair are shown in Figure 5 together with samples of the range and distribution of measured dimensions in Figure 6.

d. *Model Wheel Chairs*. In a study to check the suitability of AS 1428 and to make recommendtions for



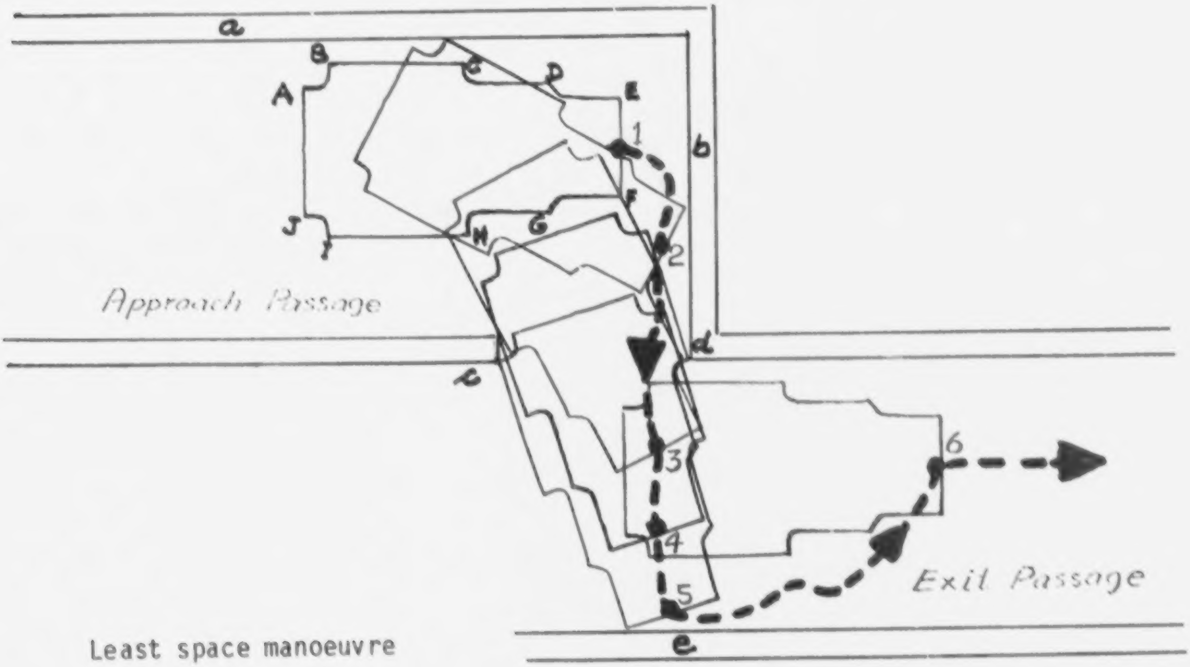
Adjustable model Wheel Chair
with silhorether at ground level
FIGURE 7

amendment of that code a 1: 5 adjustable model wheel chair was used set to the A80 dimensions. This model with associated ground level silhouettes for foot rests, wheels and hands on propelling wheel is shown in Figure 7.



Silhouette model wheel chair
with markers fitted
FIGURE 8

A silhouette—only version of a wheel chair is shown in Figure 8. This unit adjusts to the horizontal outline of a selected size wheel chair and has a pair of small rear axle wheels only that cause the motion of the chair to be similar to that of a chair with large rear wheels and 2 castered front wheels. This silhouette version can be fitted with markers that trace out the loci of selected parts of the chair as it is manoeuvred over a layout placed horizontally as shown in Figure 8.



Least space manoeuvre

FIGURE 9

Two Dimensional Space Design

The method of using the A80 wheel chair and the method of determining variance are described below for a two dimensional situation involving parallel passageways connected by an 800 door opening through a 100 separating wall and with one passage closed off at the dorway.

The procedure illustrated is typical of that used for other layout situations and for other size wheel chairs that represent particular individuals or groups for whom the design is required.

Using the 1 : 5 Model A80 wheel chair or wheeled silhouette and a 1: 5 scale layout the chair movements to negotiate the layout were determined by trial and error.

Figure 9 shows the chair movements that were found to take up least space when the door opening was 800.

For record purposes and to allow repeats of the test all that is needed is the layout, the position of the wheel chair at the start of the test and the loci of some forward part of the chair, preferably the mid-point of the front of the foot plates which will give a Centre Line Trace as shown in Figure 10.

The critical situations that occur during these chair movements are as follows:

At 1. Direction and space between chair and side wall "a" is important to allow subsequent movements. This is the starting position.

At 2. Pt B on chair is very close to wall a. Pt E on chair is in contact with wall b. From 2 to 3. Pt E slides along wall b as Pt B just touches wall a.

At 3. Pt D is in contact with wall at d, and Pt H just touching wall at c. From 3 to 4. Line BC slides along wall at d, and Line IH slides along wall at c. From 4 to 5. Sliding contact on each side of chair continues until Pt I is just clear of wall at c.

At Line BC is in contact with wall at d, Pt I is just clear of wall at c and Pt F is in contact with wall at e. From 5 to 6. With Pt F sliding along wall at e and with Line BC just clearing wall at d the chair reaches a position such as 6 and the S turn is completed.

Applied variance for door opening width of 800, 950 and 1100 were calculated based on the following considerations:

a. Applied Variance for Approach

Passageway (800 door opening)	*Variance*
Chair positioning at 1. is critical so allow for a positioning error by an actual user of 50mm	50
From position 1. to position 2. and on to 3. the chairswing must be controled so Pt B just misses the wall a, so allow for a 50mm error in swing	50
During the same movement Pt E must just slide along wall b so allow for a 50mm error	50
From position 3. to 4. the chair must be accurately positioned so contact is just maintained at wall d, so allow 50mm error	50
At the same time the direction of the chair must be correct so line IH slides along wall at c, so allow another 50mm for error	50
Total variance for approach passage with 800 doorway	250

b. Applied Variance for Exit

Passageway or 800 door opening	*Variance*
During the first part of movement from 4 to 5 the chair direction is critical to maintain contact on both sides of the chair at the one time so allow for an error of 50mm	50
Just prior to position 5 point I will clear the wall at c and the chair can then be swung to make a left hand turn. If this critical turning point is missed the exit passage needed will be wider than otherwise required so allow a positioning error to 50mm	50
As the chair is turned past position 5 Pt F must just touch the wall at e and for user error allow 50mm	50
During this turn Pt J will be well clear of wall c and the chair will move away from wall d so no allowance needs to be made for error	0
Total variance for exit passage with 800 door opening	150
By similar analysis for a doorway width of 950 it is found that provided all other critical contacts are maintained, as above, contact with the wall at c is no longer required during the approach phase but is still required during the exit phase. Thus the total variance for the approach passage is 250 – 50 =	200
and for the exit passage it remains at	150
With a doorway width of 1100 contact with wall b is no longer critical nor is contact with wall c for either the approach or the exit phase. Thus the total variance to the approach can be reduced a further 50mm to give 200 – 50 =	150
and for the exit also reduced by 50 to give 150 – 50 =	100

These variances so determined can be shown as follows:

Variance for S turn	*Doorway Width* 800	950	1100
Approach passage	250	200	150
Exit passage	150	150	100

By plotting these values, variances for intermediate doorway widths can be determined. For door widths greater than 110 use the value of variance for door width 1100.

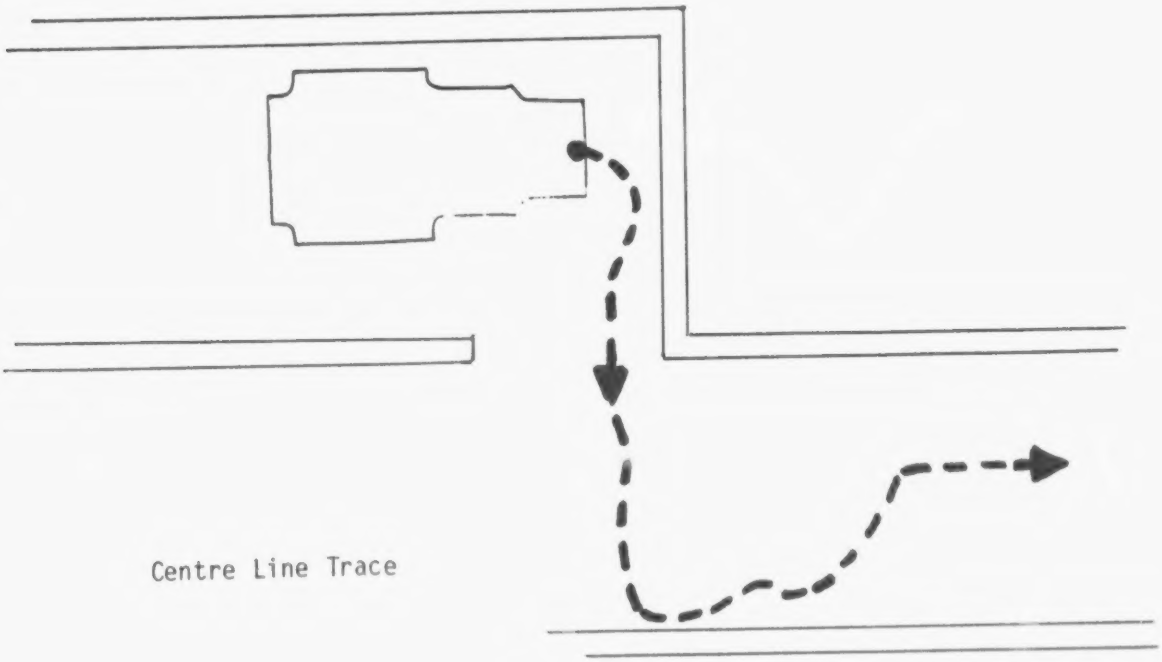


FIGURE 10

In applying the above variances we are in fact stating that the minimum size passageways needed for access by an A80 wheel chair, using the best possible manoeuvres and under perfect control, should be increased by an amount equal to the variance. This will allow access to be obtained by actual chair users who cannot be expected to position and manoeuvre their wheel chairs so precisely as was effected in tests with the A80 wheel chair.

Using the A80 wheel chair to find minimum passage width with various door openings gave the results below and allowed the minimum design dimensions for use in practice to be determined as shown:

	Door opening					
	800	900	1000	1100	1200	1300
Minimum approach passage width W1 needed by A80 wheel chair	1080	900	795	740	740	740
Applied variance	250	210	180	150	150	150
Design width W1	1330	1110	975	890	890	890
Minimum exit passage width W2 needed by A80 wheel chair	1005	940	895	860	830	780
Applied variance	150	150	130	100	100	100
Design width W2	1155	1090	1025	960	930	880

Three Dimensional Space Design

Where most elements in a space have already been located the Direct Method is recommended. Where flexibility in equipment location exists then the Profile Method is generally the more convenient method to use.

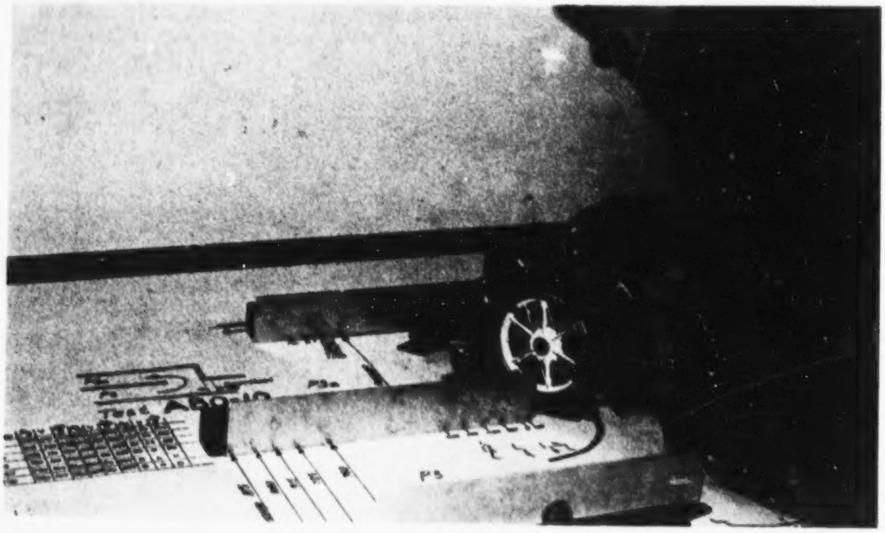
a. *The Direct Method.* In this method a three dimensional scale model wheel chair is used with a three dimensional scale layout as illustrated in Figure 11.

In the case shown in Figure 12 each of six chair positions for transfer from the wheel chair to the pan as shown in Figure 1 were considered separately to determine minimum space needs.

With doorway, pan size and position, basin size and position and walls B and C fixed, the walls D and E were moved to just permit the model wheel chair to be moved to allow the various transfer positions to be reached and for the chair to exit forwards out of the space.

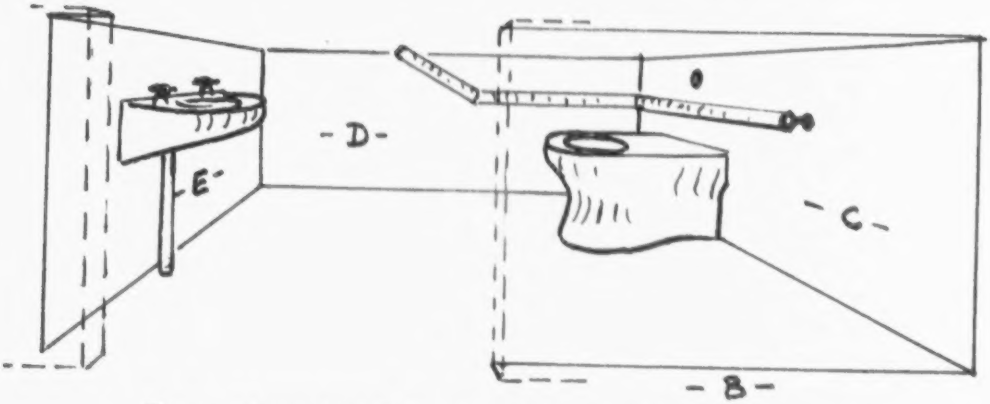
Initial chair positions on entry and centre line traces were made for each case for record purposes and to allow subsequent checking.

Applied variance was added to the minimum width and length needed by the model chair to obtain design width and length.



THREE DIMENSIONAL TESTING

FIGURE 11



Three Dimensional Layout for pan Cubicle

FIGURE 12

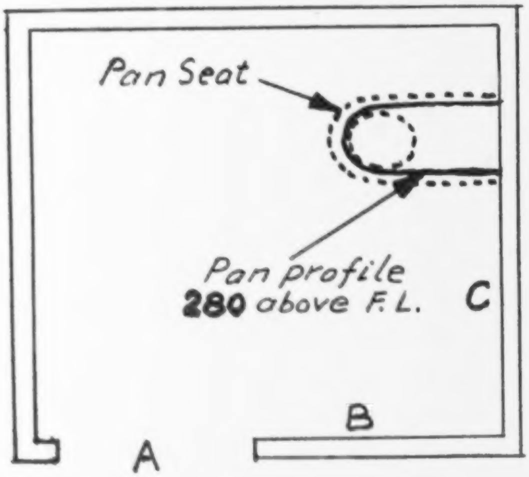
The Direct Method is ideal for checking a layout where the positions of most elements that influence space needs have been decided.

It is often found during such tests that the relocation of a particular element, for example, a hand basin, would make access and use easier and require less overall space.

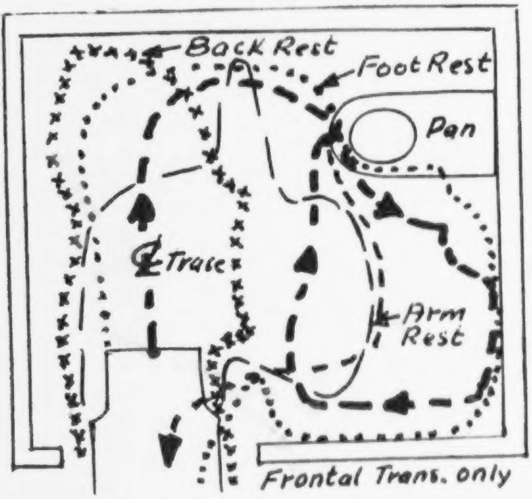
To overcome this type of problem the Profile Method was developed.

b. The Profile Method. This method uses a two dimensional scale model wheel chair fitted with markers that trace out the loci of those elements of the wheel chair and user that interface with walls and equipment in the space. This chair is used with a scale layout that includes lines showing the horizontal outline at contact level of all equipment in the space that is not subject to relocation.

In Figure 13, doorway A, wall B and C and the position of the pan seat and the profile of the pan pedestal at 280 above floor level are shown. With an A80 wheel chair the toe height is 280 and it is this part of the wheel chair that needs to clear the pan pedestal during manoeuvres.

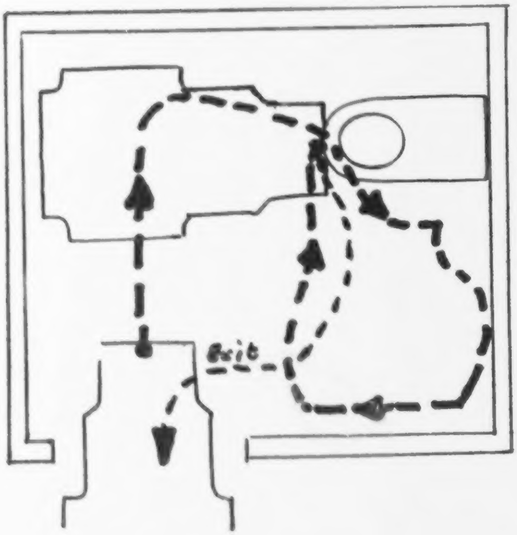


Interferrence Layout
FIGURE 13

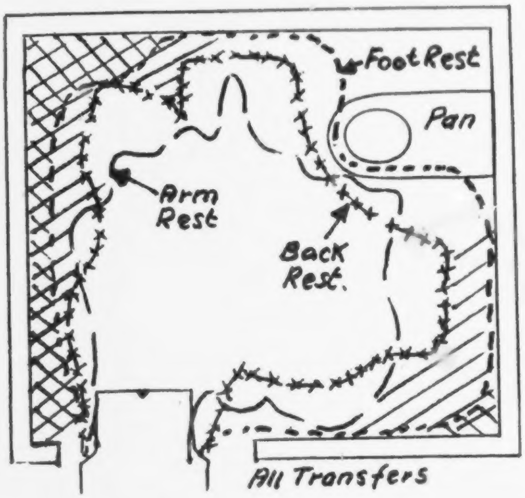


Trace of loci

FIGURE 15



Centre Line Trace
FIGURE 14



Combined loci trace

FIGURE 16

With this layout the two dimensional chair is moved through all required manoeuvres that take up the least space while the markers trace out the loci of all important elements of the wheel chair.

Figures 14 and 15 illustrate typical traces for a frontal transfer to the pan followed by forward exit from the space.

The various traces so obtained are combined as shown in Figure 16 to find the loci of key elements of the wheel chair within which all required manoeuvres are possible.

Knowing the active height range for each loci it is easy to identify what space is available for positioning equipment in the area.

As an example the down pipes from basins must clear the loci of the footrest while the basin bowl can extend over this loci but must clear the loci of the arm rests and the back rest of the wheel chair.

The double and single hatched area in figure 16 shows the available space for hand basin bowl location and the double hatched area shows where down pipes and other low level items can be located.

Spacial Design Technique in use

The following examples of use of the Spacial Design Technique illustrate the flexibility and problem solving ability of this method of design.

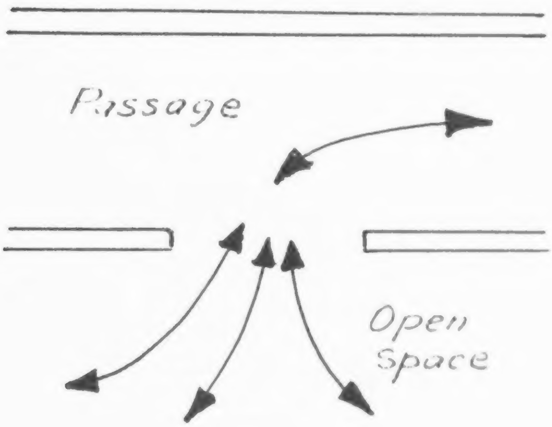
a. *Passage Way Design*

Problem: For a doorway opening from a free space through a 100 thick wall to a passage way runing at 90° to the doorway, what is the relationship between door opening and passage width that will allow free flow access each way by 80 percent of known wheelchair users? By free flow we mean continuous movement in the direction of travel without the need to backaway or perform looping movements to effect lateral shift of the rear wheels. See Figure 17.

Solution: Use of the scale model A80 wheelchair, scale layout and applied variance gave the following design values.

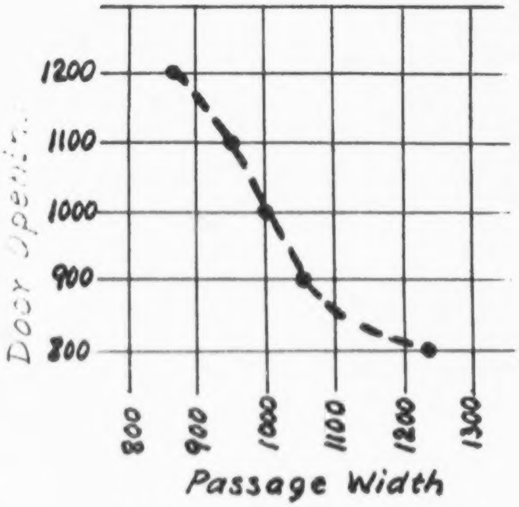
	Required passage width	
Door Opening	*Free space to passage*	*Passage to free space*
800	1230	1235*
900	1060*	1040
1000	1000*	930
1100	955*	840
1200	875*	840

For two way access the values with asterisks are selected to give the graphical solution shown in Figure 18.



Movement between open space and passage way

FIGURE 17



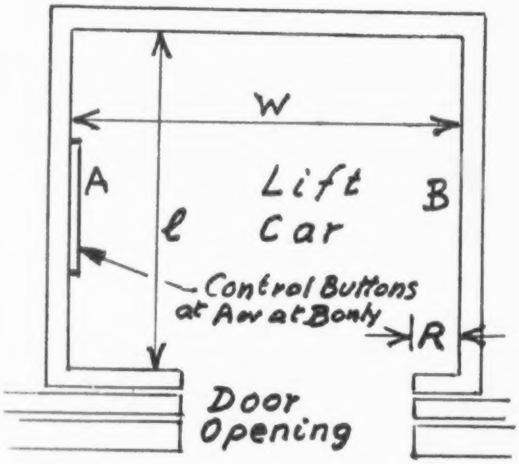
Relationship between door opening and passage width

FIGURE 18

b. *Lift Car Design*

Problem: What is the minimum size lift car that, with centred 880 door opening and with control buttons on one side wall only, is accessible to 8O percent of wheelchair users with forward entry and exit and with no more than 3 loop movements being required during entry and again during exit? What effect has door position on car size?

Note: The aim of these requirements is to ensure that a wheelchair user, alone in a lift, will be able to manoeuvre to reach the one set of control buttons even though some time and inconvenience might be involved. The aim is not to provide for an easy 180° turn within the lift. See Figure 19.



Lift car with offset door

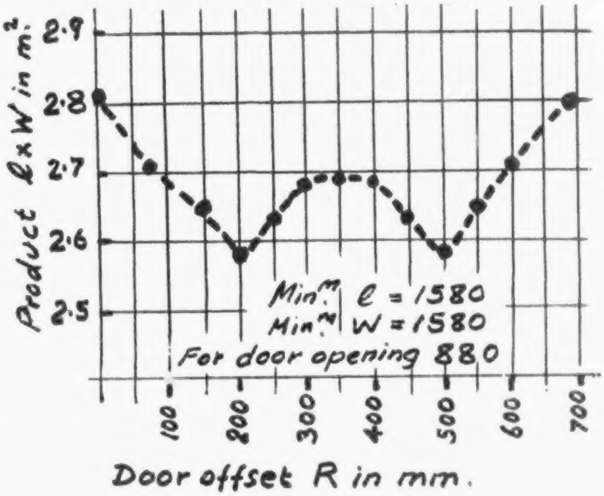
FIGURE 19

Solution: A series of tests were conducted for each door position using a scale layout and scale model A80 wheelchair with hand reach indicators for control button access.

It was found that a clear length of 1580 was needed to allow looping manoeuvres.

It was also found that minimum space was used when the chair user started a turn from a position close to but clear of a side wall and performed a series of backing movements as the turn progressed such that at the end of a 180° turn the wheelchair was backed up to the rear wall of the lift car.

Test results were used to show the relationship between door position and clear lift car floor area and a minimum lift car length and width as illustrated in Figure 20.



Relationship between door offset and lift car size

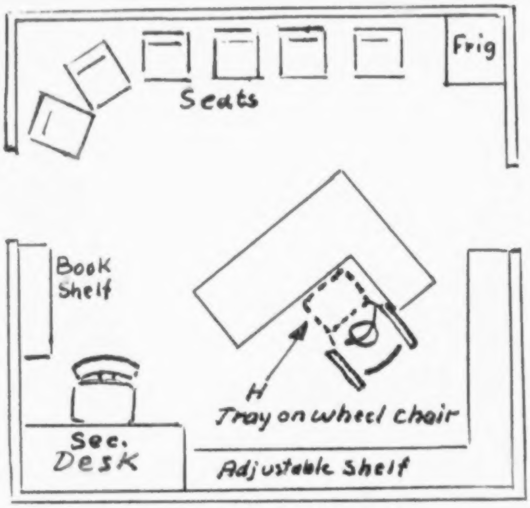
FIGURE 20

c. *Office Layout Design*

Problem: What is the most accessible arrangement of the equipment and layout shown in Figure 21 for a senior executive who uses the electric wheelchair and has the limited right-hand only reach shown in Figure 22? What special furniture would assist this executive to perform office functions including use of intercom, access and reading and disposal of files, hand writing, dictation and interviewing both able and disabled persons?

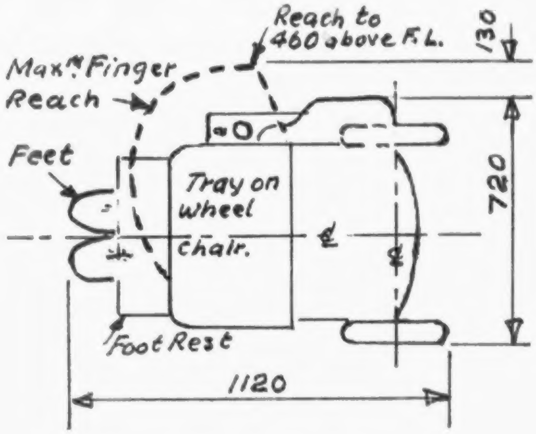
Solution: A two dimensional scale model wheelchair with hand reach indicator and proposed layouts were used initially to determine manouvering spacial needs and areas of reach for the executive.

The two dimensional scale model was then set to A80 size to determine the spacial needs and access requirements of visitors.



Initial Office Layout

FIGURE 21



Users Wheel Chair and R.H. Finger Reach

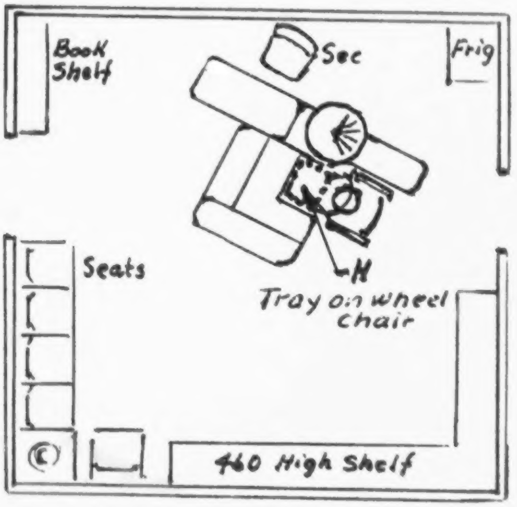
FIGURE 22

The data so obtained resulted in the layout being altered to that shown in Figure 23.

Working surfaces and shelves were then designed in plan to suit the executive and visitor needs.

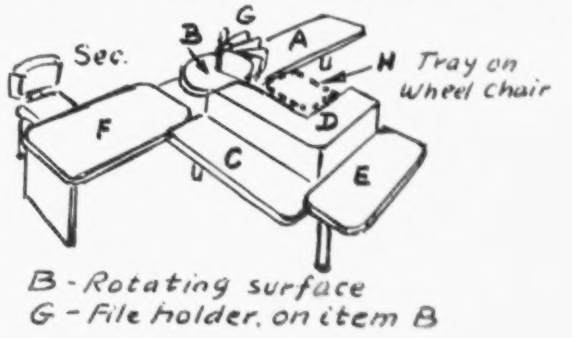
Under clearances were determined and best work surface heights decided.

Support systems for working surfaces and shelves were then designed to give needed stability and avoid interference with the movement loci. Finally a three dimensional scale layout was used with a three dimensional scale model wheelchair set to the sizes shown in Figure 24 and later to A80 size to check suitability for the executive and visitors.



Recommended Layout

FIGURE 23



Surface	Height	Surface	Height
A	460	E	760
B	480	F	700
C	600		
D	820		

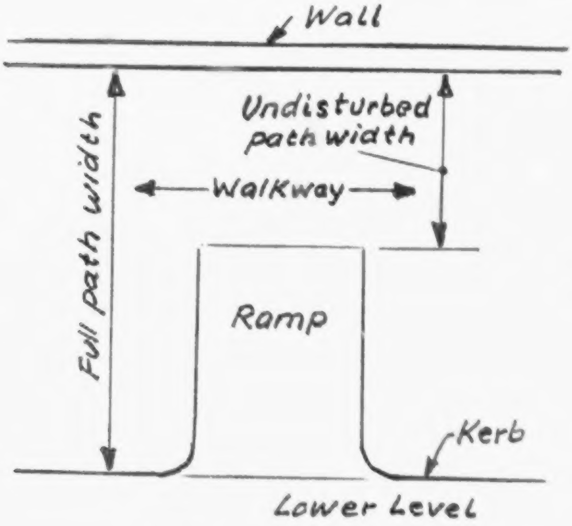
All surfaces height adjustable

B - Rotating surface
G - File holder, on item B

Recommended Desk

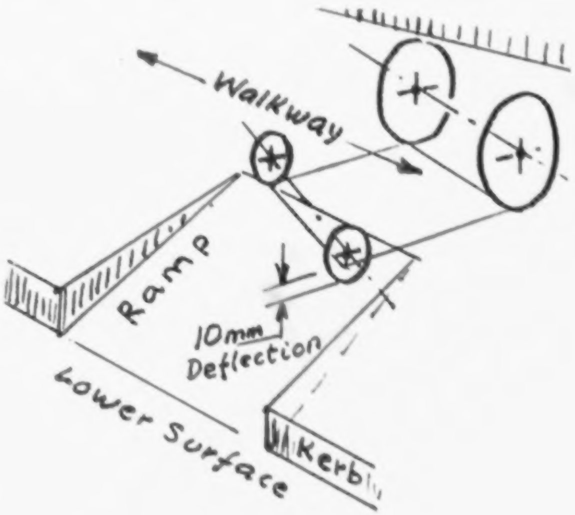
FIGURE 24

Working surfaces and shelves were then designed in plan to suit the executive and visitor needs.



Kerb ramp and walkway

FIGURE 25



10mm deflection of one wheel

FIGURE 26

d. *Path Width Design*

Problem: A short cut in ramp is to be used for wheelchair access between a footpath with a wall to one side and an adjacent flat open area at a different level.

What undisturbed path width is needed for access by an A80 size wheelchair if the ramp is 1100 wide and alternatively 900 wide?

What undisturbed path width is needed if it is assumed a 10mm deflection of one wheel of the wheelchair is acceptable with a ramp width of 1100? See Figures 25 and 26.

Solution: The various undisturbed path widths were determined firstly experimentally using a three dimensional model wheel chair set to A80 size and secondly by [illegible], as is possible in this case, as a check on accuracy. The values so obtained were as follows.

	Ramp Width		*Ramp 1100 Wide*
	900	1100	Allowing 10mm Deflection
Undisturbed Path Width need by A80 Wheelchair	1145	1145	1055
Variance	195	125	125
Design Width	1340	1270	1180

Summary

There is a need for better methods of determining the space requirements of wheel chair users. Existing codes and practices and existing experience are not always sufficient to ensure good design. Research was directed towards developing an easy to use, replicable design method that took into account both user and space variables and considered the relationship of spacial dimensions. In the research, field testing data were used to identify basic wheel chair manoeuvres, skill in use of mobility aids and wheel chair dimensions.

Adjustable three dimensional and two dimensional silhouette model wheel chairs were developed for use in space design.

Rules for determining variance were established that reflected the user errors found in full size field testing

A direct method and a profile method of special design were found to be needed to handle differeing design problems

Examples of the use of the spacial design technique illustrate the flexibility and problem solving ability of this method of design.

Too much space can be as inconvenient to some users as too little space is to others. By using this spacial design technique designers know the basis of their design, they know which wheel chair users it will suit and they can be confident the facility will be functionally sound and funds used will have been economically applied.

John H. Bails, Senior Research Officer, Technical Policy Unit, Public Buildings Department, Adelaide, South Australia, Australia.

AUTO-RIDE—A VIDEOTEX-BASED, PARATAXI SYSTEM OF LOW COST, DOOR-TO-DOOR, TRANSIT SERVICES

Robert W. Behnke
and
Malcolm McLeod

Introduction

According to Webber, "Prospects are promising for an urban transportation system that combines private use of private automobiles with public use of public automobiles and other shared vehicles that use streets and freeways. No brave-new-world transport technology is called for. No shiny trains and ornate subway stations. Merely prosaic buses, vans, and automobiles operated more intelligently.

We have already evolved the world's most effective transport system, and it already offers extraordinary mobility to a large proportion of Americans. It is not new vehicle types that we need. Nor do we need to spend a lot of money to create a lot of new travelways.

Our task, instead, is to extend 'automobility' to those who do not yet enjoy it and to do so without unduly increasing congestion, pollution, or energy consumption. We need neither huge investment in outdated rail technology nor a Manhattan project to develop post-modern new transport technology.

We already have plenty of roads and plenty of underused vehicles. We just need to manage those resources more effectively and more equitably."[1]

The advent of new telecommunications services, such as videotax, will provide transportation agencies with new capabilities that can help make Webber's vision a reality. Easy to use videotex terminals will permit communities of almost any size to integrate buses, vans, taxis and private automobiles into a low-cost, door-to-door public transit system.

In addition to increasing the mobility of all citizens, including the elderly and handicapped, a community videotex system can provide residents with a variety of new recreational, educational and employment opportunities. Most of the costs of installing a community videotex system will be paid by advertisers and local businesses.

This paper describes videotex, the Auto-Ride parataxi concept, and how it can complement and supplement conventional transit, paratransit and ridesharing services. It presents the major findings of a study conducted for the State of Hawaii, using Federal Highway Administration (FHWA) funding, to analyze the potential of videotex to reduce a variety of transportation, energy and environmental problems. The State of Hawaii is organizing a public-private partnership to test the Auto-Ride concept in a community of approximately twenty-five thousand residents.

As Wohl put it, "The goals of urban transportation are so often viewed as reducing downtown traffic congestion, improving suburban-to-downtown commuting, and "getting people out of cars into transit." We look too little at the ultimate purpose, which is fast, efficient transportation. The most talked about "means" for reaching our goals usually include the construction or extension of suburban rapid transit lines as well as subsidies for new and existing facilities, transit fare reduction (if not free transit), the banning of automobiles in the downtown area, parking fee surcharges, and congestion tolls for autos. This kind of rhetoric rarely gains us more than heavy capital commitments for new or extended transit lines, new but still conventional buses or rail cars, and heavier transit deficits. Traffic congestion is not reduced; transit service seems little better—at least for most urban dwellers—and the problems of pollution, noise, and energy consumption remain unabated."[2]

Wohl has been a long-term advocate of changing taxi regulations to improve the availability, usage and financial viability of these paratransit vehicles. By eliminating regulations against shared-ride taxi services, for example, cab owners could not only increase profits, they could also reduce fares and conserve fuel. This, in turn, would provide important benefits to those aged and handicapped riders who need door-to-door transportation services and guaranteed seating.

Background

Mass transit systems and carpools are making an important contribution to energy conservation. However, it is doubtful that this contribution will increase in the future. Although public transit systems received billions of dollars of federal and state aid between 1969 and 1979, the percentage of commuters who use rail and bus services decreased from 10 percent to 6 percent during this period. This is a 40 percent loss in transit's market share during a decade in which there were two gasoline crises and the cost of owning and operating an automobile increased dramatically. During this same decade, despite an extensive campaign to encourage carpools, there was an overall increase in the use of single-occupant automobiles for commuter travel. To paraphrase a Honolulu columnist,: "Carpools are like broiled liver—cheap, good for you and unpopular. To date, despite bumper sticker propaganda to the contrary, they don't work for most people."

---

[1] Melvin Webber, Institute of Urban and Regional Development, University of California -Berkeley, at the Governor's Conference on Videotex, Transportation and Energy Conservation in Honolulu (no date).

[2] Martin Wohl, Professor of Transportation System Planning at Carnegie-Mellon University and one of the authors of the RAND Corporation Report "The Urban Transportation Problem" (no date).

Some conservationists may question the preceeding statements about the limited energy saving potential of both carpools and mass transit. It should be noted that these conclusions were developed before the current administration in Washington took office and announced plans to reduce federal spending on public transportation.

In 1970, our national bill for imported oil was $3 billion. In 1978, it was $42 billion. In 1980, even though conservation efforts and the recession significantly reduced the volume of oil imports, the price for these imports exceeded $80 billion. This is equivalent to every family of four sending $1,600 out of this country every year and it is a major reason for our country's inflation and balance-of-payments problems.

The transportation sector uses approximately half of the oil used in the United States and the private automobile consumes over half of this amount. American car owners consume one-ninth of all the oil used in the world every day. The improvement in the mileage efficiency of the automobile population will make an increasing contribution to the U.S. energy conservation program. To make a similar contribution to our transit systems, it will be necessary to broaden our concept of ridesharing to include non-commuter travel and vehicles operated for a profit. It will also be necessary to broaden our concept of public transit to include a variety of new, innovative transportation services.

Because of our continued dependence on imported oil, our increasing transportation and environmental problems and the proposed federal cutbacks in operating subsidies for transit and carpooling operations, a growing number of transportation specialist are recommending that regulations also be changed to permit individuals to use their own personal vehicles to supply local transportation services on a quasi-business basis. Unlike carpools and vanpools, which must be operated on a not-for-profit basis, the proposed "paraprivate" transportation services would generate income for driver-owners. This approach could add enormous transportation capacity at little or no additional cost to the public.

Clearly, public transportation officials at all levels need to ask themselves, "What are we trying to do?", and restructure services to address this question. We can no longer continue to use nineteenth-century work rules and early twentieth-century technology as we stumble toward the twenty-first century.

AUTO-RIDE: An Innovative Ride-Sharing System

The microcomputer, a prime example of late twentieth century technology, provides some new tools to help public transportation officials integrate transit, paratransit, ridesharing and paraprivate resources into a more cost-effective, more energy-efficient transport system. One corporation, for example, has designed an automated, door-to-door transportation system, called AUTO-RIDE, that utilizes low-cost videotex terminals to rapidly match would-be riders with would-be drivers on a trip-by-trip basis. AUTO-RIDE is a supplemental transportation service that attempts to combine the comfort and convenience of the taxi with the economy and energy conservation characteristics of the carpool. The advent of the microcomputer and videotex makes AUTO-RIDE a technically feasible concept today.

Videotex is the name given to an easy-to-use, two-way consumer information delivery system. Users in homes, offices and shops can call for information from a variety of remote sources and display it on an ordinary TV set using a low cost, microcomputer keyboard. The information carrier can be either a telephone line, TV cable or a radio link. Once installed in a community, a videotex network connects businesses and home creating a new two-way video communications medium in which users can make reservations, purchase goods, pay bills, receive training and exchange electronic mail. Perhaps the most widely publicized application of this technology is France's plan to install 270,000 videotex terminals in a suburb of Paris to replace printed telephone directories and reduce the cost of directory assistance services.

The AUTO-RIDE System employs low-cost, easy-to use videotex terminals to instantly collect trip requests from riders and trip offers from drivers Because of the speed and flexibility of the modern microcomputer, detailed trip information (e.g. origin, destination, departure time, seating) can usually be entered by pressing one or two buttons on the terminal keyboard. This information, after being checked for accuracy and completeness, is then automatically transmitted to a central computer. After careful security checks are performed, the central computer matches drivers and riders to form, in effect, single-trip carpools. Confirming and coordinating messages are then transmitted back to the terminals for the drivers and riders.

It is envisioned that the AUTO-RIDE system will use a mix of professional taxi drivers and part-time drivers to provide demand-responsive (i.e. on-call) transportation services. Fares, comparable to those of existing public transit systems, will be billed monthly by the central computer. Since only a small portion of these fares will be needed to support the central computer system, most of the fares can be used to provide financial incentives for AUTO-RIDE drivers and to subsidize operators of taxi-cabs or specialized vehicles for the handicapped.

The State of Hawaii and the City and County of Honolulu claim leadership in energy conservation and in the use of both carpools and public transit. In a Bureau of the Census report that analyzed travel to work in 20 U.S. metropolitan areas, Honolulu led all cities in the percentage of commuters using carpools and was second only to New York City in the percentage of commuters using public transit. Honolulu's current ridership levels are actually higher than the long-term ridesharing and transit ridership goals of some mainland cities. Nevertheless, Honolulu has serious traffic congestion problems that are getting worse every year.

In 1975, Hawaii's Department of Transportation started a series of seminars to consider ways to limit the number of vehicles on the island of Oahu, that is, in the City and County of Honolulu. The Director of the Hawaii Department of Transportation, pointed out at that time, that it would be unrealistic to attempt to limit the number of automobiles on Oahu until an alternative method of transportation was available to the public. Without a cost-effective public transit system, the various tax disincentives that were proposed to rsduce the number of automobiles on Oahu would have placed a disproportionate financial burden on the poor. Both the State of Hawaii and the City and County of Honolulu have been conducting evaluations of a variety of transportation concepts in an attempt to develop a more cost-effective public transit system for Oahu.

In February 1982, Aegis Systems Corporation was awarded a contract by the Department of Transportation to conduct a six-month study of the costs and benefits of installing a videotex based ridesharing system on Oahu. The following are the major conclusions of this study:

- A real-time rideshare matching system, such as AUTO-RIDE, is both technically and economically feasible for Oahu.
- The door-to-door features of AUTO-RIDE are ideal for many young, elderly and handicapped riders, and very desireable for most others. Like the taxi, AUTO-RIDE offers riders a level of service that is competitive with the automobile for both commuter and non-commuter travel. It also eliminates parking and driving chores.
- By providing a feeder service in the more remote areas of Oahu, AUTO-RIDE can stimulate use of bus services. By providing convenient back-up transportation, AUTO-RIDE can also stimulate the use of commuter carpools and vanpools. On rainy days it will help those who normally walk or bike to work.
- Videotex terminals can be used to provide current information on the arrival times of buses at any bus stop. Computerized Rider Information Systems (CRIS) have already demonstrated the ability to increase offpeak ridership on fixed route bus systems. The terminals can also be used for a variety of "third wave" applications, such as home-banking, electronic mail, shop-at-home and telecommuting
- AUTO-RIDE can increase full-time employment opportunities in both public and private transportation and in a variety of high-technology industries. It can also increase part-time employment opportunities for a large number of vehicles owners who are willing to provide rides to neighbors, co-workers and other qualified residents.
- AUTO-RIDE can complement and supplement existing transportation services. Its videotex terminal network can help integrate transit, paratransit, ridesharing and paraprivate resources into a more cost-effective, more energy-efficient public transportation system.
- An integrated, multi-modal public transportation system can reduce Oahu's dependence on both the one-person auto and imported oil. It can increase the mobility of the transportation disadvantaged. It can also reduce traffic congestion, air pollution, parking problems and government spending on transportation projects
- AUTO-RIDE will become even more cost-effective in the future as the cost of electronic equipment decreases and the cost of building and operating conventional mass transit systems increases.

The following were the major recommendations of this study:

- Hawaii should broaden its concepts of both ridesharing and public transportation. Ridesharing should not be limited to carpools and vanpools; public transit should not be limited to to mass transit
- Regulatory obstacles to innovative paratransit and paraprivate systems should be eliminated.
- Equitable insurance arrangemants and fare structures should be developed for operators of paratransit and paraprivate vehicles.
- An AUTO-RIDE system feasibility study should be conducted for each of the major neighbor islands.

- Hawaii should support the development of a prototype AUTO-RIDE system with 10,000-15,000 videotex terminals somewhere in the United States to test the concept operationally.

Robert Behnke is President of Aegis Transportation Information Systems, Honolulu, Hawaii 96813.

Malcolm McLeod is with the Hawaii Department of Transportation, Honolulu, Hawaii.

THE IMPACT ON VEHICLE ROUTING OF VARIOUS OPERATIONAL RULES OF A TRANSPORTATION SYSTEM FOR HANDICAPPED PERSONS

Jean-Pierre Belisle, Francois Soumis, Serge Roy, Jacques Desrosiers, Yvan Dumas and Jean-Marc Rousseau

Introduction

This paper presents some preliminary results from an ongoing study of the impact of various operating scenarios on the construction and quality of routes in a system for the transportation of the handicapped. The study began in 1984 at the University of Montreal, Transportation Research Center. In this paper, we analyze the results obtained so far for a subset of external strategies which have been tested and compared in a representative real problem in a simulation mode.

The Main Scenarios

Based on the fundamental differences presently existing in the operations of transportation services for the handicapped in large Canadian cities, three main operating scenarios were developed. The distinctions between these scenarios concern mainly fleet composition and the method of handling service requests from occasional users. For the type of vehicles used to transport users, we have chosen two working hypotheses: 1) the use of a fleet made up entirely of minibuses, 2) the use of a fleet made up mainly of taxis. For the method used to handle advance requests from occasional users, we have considered two policies: 1) a call-back policy, in which the request is noted at the time the user calls and the user is called back later to confirm the service and time of departure, 2) a no call-back policy, in which a final response is given to the user at the time of calling. The call-back policy simplifies route planning, but involves a complex and costly call-back procedure. The no call-back policy avoids this costly task, but necessitates an immediate analysis of the request. It is difficult to choose between these two approaches exept when taxis are largely used. In this latter case, route planning becomes a relatively simple matter and it would be superfluous to consider using a call-back policy. We define the three main scenarios as follows:

Scenario number	*Vehicles used to transport users*	*Advance request handling policy*
1	minibuses	call-back
2	minibuses	no call-back
3*	mainly taxis	no call-back

* Some variants of this scenario are explained in Section 4.

Transportation System Operating Rules

In order not to confuse the issue and to ensure compatibility with the experience of as many cities as possible, we defined some fairly simple operating rules.

We begin by identifying two types of requests: regular and occasional. A regular request belongs to an established list and recurs at regular intervals. Regular requests are known well in advance. All other requests are identified as occasional; they have to be formulated within a certain period before the service time required. This reservation period may vary from a period of 24 hours to one week prior to the desired service time. As a compromise, we ruled that occasional requests could be formulated during one of the three days prior to the service day (we identify these days as D3, D2 and D1) by telephoning between 9:00 a.m. and 6:00 p.m. They can also be formulated on the day of service (identified as DO) with the condition that calls must be made at least one hour before the service time required for a departure request or 2½ hours beforehand for an arrival request. To avoid unnecessary policy discussions concerning which types of request should be refused and the impact these requests may have on operational efficiency, and to allow the evaluation and comparison of fleet sizes necessary to respond to the demand, we guarantee service to all requests formulated before DO.

Cancellations are allowed after booking. A cancellation may be made by calling the cancellation service between 5:00 a.m. and 6:00 p.m. Cancellations on DO are assumed to have been made at least one hour before the service time for a departure request or 2½ hours beforehand for an arrival request.

The service time requested is guaranteed. This means that no pickups can occur before the desired pickup time and no deliveries can occur after the desired delivery time. Departure time is confirmed to a user in terms of a 15 minute time interval. We guarantee that a vehicle will show up within this interval.

A maximum capacity was established for the minibuses and taxis. It was assumed that minibuses continued seats for up to 6 passengers and space for up to 5 wheelchairs. For taxis, we assumed a limit of 3 passengers with 2 folding wheelchairs. Finally, we assumed that the minibuses were equipped with radio telephones allowing the operations service to communicate with drivers concerning modifications to the route caused by cancellations and last minute requests during operations.

Data Used To Simulate A Working Day

To simulate a working day, we used a data file describing the requests used to plan operations on January 27, 1983 for the Wheel-Trans Service in Toronto. The file included 1096 requests made up of 410 regular requests and 686 occasional requests each corresponding to a single trip (i.e. in one direction only). The following information was available on each request:

—request identification (client number)

—name of group or client

—address of origin

—destination address

—service type required (arrival or departure)

—number of passengers (including the number who are ambulatory, the number of wheelchairs and the number of accompanying persons)

—service time required.

We also used minibus pieces of work similar to those used in Toronto.

No data was available concerning which of the requests correspond to possible taxi trips, as well as the days and times on which the occasional requests were called in. This information was generated by simulation. In this simulation, we assumed that half of the users in wheelchairs used a folding chair and can therefore travel by taxi, and we distributed the 686 occasional requests as follows:

—190 requests formulated on day D3 (i.e. 3 days before the service day)

—190 requests formulated on day D2 (i.e. 2 days before the service day)

—190 requests formulated on day D1 (i.e. 1 day before the service day)

—116 requests formulated on day DO (i.e. 0 day before the service day)

For realism, it then seemed necessary to take into account a fairly high cancellation rate. In the absence of more detailed data, we made the following assumptions about the distribution of cancellations over the period:

cancellations

cancellations requests	*formulated in D3*	*formulated in D2*	*formulated in D1*	*formulated in DO*	*Total*
regular (410)	12	12	12	24	60
occasional formulated:					
D3 (190)	5	5	15	25	50
D2 (190)	—	5	10	30	45
D1 (190)	—	—	5	25	30
DO (116)	—	—	—	6	6
	17	22	42	110	191

The cancellation rate generated in this way is 17.4% which is in the range of the cancellation rates observed in many Canadian cities (Bunt, et al 1980; Transport Canada, March 1979).

Note finally, that a handling time was associated with each request to allow for embarkation and disembarkation of passengers. We also identified the minimum time, called the "direct taxi travel time", necessary to transport a passenger from the origin to the destination. The evaluation of handling times, taxi-times and other trip times involved in this type of planning problem are discussed in (Roy et al, 1984).

The Route Construction Procedure And Application

Our route construction procedure involves two main algorithms which we identify as algorithms A and B. Algorithm A has two functions: to construct a set of trips enabling a set of existing routes with the possibility of initializing new routes if necessary. Algorithm B serves to reorganize and improve on the solution obtained through algorithm A.

Algorithm A is heuristic based on a parallel insertion technique (Chapleau et al, 1982).It is explained in detail in a C.D.T. publication (Roy et al, 1984). Algorithm B uses dynamic programming (5) and integer linear programming with column generation (6). This algorithm is the focus of two publications (Desrosiers et al, 1984(a) and (b)).

For the first two scenarios, route construction proceeds in three phases.

The first phase is common to both scenarios and involves the construction of routes to satisfy all regular requests This phase can be carried out prior to D3. Algorithm A is used to produce an initial solution which is then improved by algorithm B.

The second phase is carried out during D3, D2 and D1. It is carried out differently in the two scenarios In scenario 1 (call-back), we carry out 3 batch runs to handle the incoming calls. These runs occur at the end of D2, middle of D1 and end of D1 (i.e. at 6:00 p.m.). Each of these necessitates the withdrawal of the cancelled requests, the insertion of new requests and initialization of new routes, using algorithm A, and the improvement of the routes, using algorithm B. Each batch run generates a call-back task. In scenario 2, each incoming call generates some kind of computer treatment. If the call is to cancel a request, this request is withdrawn from an existing route. If it is a new request, an attempt is made to insert it into an existing route using algorithm A. If this fails a new route is initialized. At the end of each day algorithm B is used to improve the routes constructed.

The third and final phase is carried out during DO in a similar way for both scenarios. Each call is immediately handled. If the call is cancellation, the corresponding request is withdrawn from the route. If the call is a new request, an attempt is made to insert it into an existing route using algorithm A. If this is impossible, the request is refused since a new route cannot be initialized on DO.

In the third scenario we split the requests into transferable and untransferable calls. A request is identified as untransferable if it involves a user unable to travel by taxi. All other requests are identified as transferable.

Since the untransferable requests necessitate transport by minibus, we proceed as in scenario 2 for these requests This implies that the number of minibuses to be used in this scenario is determined by the treatment of the untransferable requests formulated before DO. An untransferable request formulated on DO is accepted only if it is possible to insert it into an existing minibus route.

We have considered three variants in the treatment of the transferable requests. In each of these variants, identified as variants A, B and C, each incoming call during D3, D2 and D1 generates a confirmation of the pickup time as if the user(s) was to travel by taxi. The distinctions between the three variants occur at the end of D1. In variant A, one taxi is scheduled to serve each request. In variant B we rationalize the use of minibuses by inserting some transferable requests into minibus routes. As many insertions as possible are carried out while respecting this confirmed departure time interval already given to users. In variant C, we proceed as in variant B but we also group together the remaining transferable requests in order to allow as many taxis as possible to serve more than one request at a time. In the three variants, each transferable request formulated on DO generates a taxi trip. Note finally that in the third scenario, the only requests which can be refused are some of the untransferable requests formulated on DO.

Analysis Of Results

The main results obtained for the scenarios are described in Tables 1, 2 and 3 presented at the end in this paper. Table 1 describes problem characteristics and certain route statistics for each scenario. Table 2 presents the means of various ratios used to evaluate the productivity of minibus routes. For each route obtained in a scenario we have computed four ratios:

1) driver productivity $= \dfrac{\text{number of passengers carried}}{\text{duration of the piece of work}}$

2) vehicle productivity $= \dfrac{\text{number of passengers carried}}{\text{useful portion of the piece of work}}$

where the useful portion of the piece of work is the sum of handling and vehicle movement times.

3) non-empty vehicle productivity $= \dfrac{\text{number of passengers carried}}{\text{productive portion of the piece of work}}$

where the productive portion of the piece of work is the sum of handling times and vehicle movement time with passengers,

4) taxi/minibus productivity $= \dfrac{\text{sum of handling and direct taxi travel times}}{\text{productive portion of the piece of work}}$

Finally, Table 3 presents the means of three measures used to evalaute the quality of service produced by each scenario. For each request we have measured:

1) service delay : deviation from the desired service time,
2) excess travel time: difference between the time spent in the minibus and the direct taxi travel time,
3) minibus-taxi ratio: travel time in the minibus direct taxi travel time

Note that the first two measures are always greater than or equal to zero while the minibus-taxi ratio is greater than or equal to one. A perfect quality of service would imply that both service delay and excess travel time are equal to zero and that the minibus-taxi ratio is equal to one.

We now examine the results obtained, beginning with a comparison of scenarios 1 and 2. The figures in Table 1 show that route operating costs are higher with scenario 2. In fact, although the total travel time for scenario 1 is 2 hours 13 minutes greater than for scenario 2, scenario 2 requires two additional pieces of work (i.e. 21½ additional hours of wages) making it more costly. It should be remembered, however, that scenario 1 generates a call-back task which needs to be balanced against these costs. The policy of calling back all users reserving during periods D3, D2 and D1 generated three call-back tasks: 365 calls on the morning of D1, 89 calls on the afternoon of D1 and 99 calls on the evening of D1. Any cost analysis should also take into account that scenario 2 requires more real time transactions than scenario 1. scenario 1 generated 226 real time transactions while scenario 2

Table 1

Problem characteristics and route statistics	*Scenarios*				
	1	*2*	*3A*	*3B*	*3C*
Number of requests received	1096	1096	1096	1096	1096
Number of requests cancenlled	191	191	191	191	191
Number of requests accepted	894	895	903	895	895
Number of requests refused	11	10	2	10	10
Number of requests served by minibus	894	895	210	338	338
Number of requests served by taxi	—	—	693	557	557*
Number of minibus routes	50	52	19	19	19
Number of taxi trips	—	—	693	557	488*
Total vehicle movement time:					
—minibuses	311h97m	308h54m	95h27m	130h16m	130h16m
—taxis	—	—	193h39m	170h12m	155h10m
Total minibus movement time with passengers	226h45m	226h31m	61h54m	85h06m	85h 06m
Total handling time for minibus drivers	74h30m	74h40m	22h04m	31h22m	31h22m
Total duration of the minibus pieces of work	594h30m	616h00m	212h30m	212h30m	212h30m

* In scenario 3c, 115 requests served by taxi are grouped together into 46 taxis. This implies a gain of 69 taxi trips.

Table 2

Productivity of the minibus routes	*Mean of the productivity ratios*			
	Driver Productivity	*Vehicle Productivity*	*Non-empty vehicle Productivity*	*Taxi-minibus Productivity*
Scenario 1 (50 routes)	1.69	2.61	3.36	1.08
Scenario 2 (52 routes)	1.62	2.63	3.41	1.08
Scenario 3A (19 routes)	1.31	2.29	3.31	0.99
Scenario 3B (19 routes)	1.94	2.52	3.55	0.97
Scenario 3C (19 routes)	1.94	2.52	3.55	0.97

Table 3

Quality of service analysis	*Mean of the*		
	Service delays	*Excess travel times*	*Minibus taxi ratios*
Scenario 1			
Minibuses (894 requests)	14.8 min.	19.4 min.	2.5
Scenario 2			
Minibuses (895 requests)	13.6 min.	19.5 min.	2.5
Scenario 3A			
Minibuses (210 requests)	20.2 min.	23.5 min.	2.7
Taxis (693 requests in individual trips)	0.0 min.	0.0 min.	1.0
Scenario 3B			
Minibuses (338 requests)	14.4 min.	20.7 min.	2.7
Taxis (557 requests in individual trips)	0.0 min.	0.0 min.	1.0
Scenario 3C			
Minibuses (338 requests)	14.4 min.	20.7 min.	2.7
Taxis (115 requests regrouped in 46 trips)	3.0 min.	10.9 min.	1.6
(442 requests in individual trips)	0.0 min.	0.0 min.	1.0

generated 877 of these. Table 2 reveals that in terms of global productivity (measured by driver productivity) scenario 1 seems to be only slightly better than scenario 2. This is mainly due to the fact that there is more wasted time in the pieces of work of scenario 2. However the differences in the ratios obtained for the two scenarios are less important than what could be expected from two scenarios for which planning times are so different. Finally, Table 3 shows very little difference in the quality of service generated by each scenario.

The mean values of the taxi-minibus productivity ratios (Table 2) obtained for scenarios 1 and 2 are 1.08 in both cases. This implies that the total time which would be spent handling and transporting customers on a minibus route with individual taxi trips for each request would not be much higher than the time spent on these activities by a minibus driver. This leads us to the study of scenarios 3 in which most of the customers are transported by taxis. The results presented in Table 1 for variant A of scenario 3 show that money would be saved if all transferable requests were served by individual taxi trips. The results for variants B and C show that these savings could be increased by the insertion of some transferable requests into the minibus routes needed fo rthe untransferable requests, and by the grouping together of some of the taxi trips. Table 2 describes the gain in productivity obtained by the rationalization of the minibus routes carried out in variants B and C. Finally, Table 3 shows that the quality of service for such routes is comparable with that obtained in scenarios 1 and 2. It also shows that the grouping together of some of the taxi trips does not unduly affect the quality of service offered to the users.

Conclusion

From the reuslts obtained in our simulation of a working day for each of 3 scenarios, two main conclusions can be drawn. One, transportation service for handicapped persons is more like a taxi service than a bus service. Two, the choice between a call-back or a no call-back policy is more a question of organization than a question of improvement in the quality of service and productivity. In scenario one, a major call- back task is generated and, in scenario two, a large number of real time transactions have to be carried out.

We intend to continue carrying out simulations of working days under different assumptions. The impact on productivity and quality of service of 1) the length of the confirmed departure time interval, 2) the cancellation rate, 3) a demand increase, and 4) the vehicle size, are among the next subjects to be investigated We also plan to study the operations of some large taxi systems already in operation (Quebec City, Calgary, etc.) in order to determine the appropriate level of taxi use.

Note finally that a more detailed report on the results already obtained and on the methodology used will be available in 1985 from the Transportation Research Center, University of Montreal.

References

Bunt, P.D., Miller, E.J. and Wolf, R.N. Wheel-Trans Feasibility of Computer-Aided Reservations, Scheduling and Dispatching. Final report. Toronto, University of Toronto York University, Joint Program in Transportation, August 1980, 136 p.

Chapleau, L., Ferland, J., Lapalme, G. and Rousseau, J.M. A Parallel Insert Method for the Capcited Arc Routing Problem. Montreal, Centre de recherche sur les transports, Universite de Montreal, 1982, (Publication 234).

Desrosiers, J., Dumas, Y. and Soumis, F. A Dynamic Programming Method for the Large Scale Single Vehicle Dial-a-Ride Problem With time Windows. Centre de recherche sur les transports, Universite de Montreal, 1984 (a), (Publication 361).

Desrosiers, J., Dumas, Y. and Soumis, F. The Multiple Vehicles Many to Many Routing Problem With Time Windows. Montreal, Centre de recherche sur les transports, Universite de Montreal, 1984 (b), (Publication 362).

Desrosiers, J., Pelletier, P. et Soumis, F. "Plus court chemin avec contraintes d'horaires". RAIRO-Recherche operationnelle. Vol. 17, No. 4, Novembre 1983, pp. 357-377.

Desrosiers, J., Soumis, F. and Desrochers, M. "Routing With Time Windows by Column Generation". HEC - G-83-N. NEWORKS, Vol. 14, 1984.

Roy, S., Rousseau, J.M., Lapalme, G. and Ferland, J. Routing and Scheduling for the Transportation of Disabled Persons—The Algorithm. Montreal, Transport Canada, Transport Development Centre, 1984 (TP 5596 E).

Roy, S. Rousseau, J.M., Lapalme, G. and Ferland, J. Routing and Scheduling for the Transportation of Disabled Persons. The Test Problems and The Evaluation of Results. Montreal, Transport Canada, Transport Development Centre, 1984. (TP 5598 E).

Urban Transportation Research Branch. Operational Improvements for Special Transportation Services for the Handicapped. Montreal, Transport Canada, March 1979.

Jean-Marc Rousseau is the Director, Serge Roy is a Research Assistant, and Jean-Pierre Belisle is a Teaching Assistant with the Transportation Research Center, University of Montreal, Montreal, Quebec, Canada H3V 1H8.

Francois Soumis is an Assistant Professor with Ecole Polytechnique, P.0. Box 6079, Station A Montreal, Quebec, Canada H3C 3A7.

Jean-Pierre Belisle is a Teaching Assistant with the Ecole des Hautes Etudes Commerciales, 5255 Avenue Descelles, Montreal, Quebec, Canada H3T 1V6.

A CONJOINT ANALYSIS OF THE PREFERENCE FOR SERVICE BY HANDICAPPED PERSONS

Julian Benjamin

Introduction

The travel problems of handicapped individuals have been recognized since the Rehabilitation Act of 1973. In its newest proposed regulations UMTA provides "minimum criteria for the provision of transportation services" for handicapped persons. These criteria provide for a mixture of accessible fixed route or special services which are comparable to conventional services with respect to coverage area, days and hours of service, fares freedom from trip purpose restrictions, and unreasonable waits. The precise definition of comparability is left to the local transit agency. This study proposed that the consumers of these services—the handicapped people for whom these services are intended—be an integral part of the process by which services are designed. Further, since special and conventional services are by definition not exactly the same, it is proposed that the preferences and tradeoffs made by handicapped persons be used to determine comparabillty. The methodology includes the use of conjoint measurement of consumer preferences and is illustrated in a data set collected and analyzed for disabled residents of Greensboro, North Carolina.

Prior Studies of Travel Needs

A variety of studies have been completed which measure the travel needs and travel barriers of the transportation handicapped. These include studies by Michaels and Wiler (1974), ARI (1977), Grey Advertising (1978) and Benjamin and Sen (1982b). For the most part, these studies focus on the physical barriers to travel experienced by handicapped persons such as the inaccessibility of most facilities to wheelchairs. The studies did not assess tradeoffs between specific levels of attributes and provided little guidance for the level of service provided once physical barriers are overcome.

Studies of Consumer Tradeoffs

Methods which assess the tradeoffs made by consumers between product attributes have been developed for more than a decade. These consist of experimental methods in which subjects are asked to compare items systematically according to their preference. These techniques include tradeoff analysis (Johnson 1984), conjoint measurement (Green & Wind 1973), information integration analysis (Anderson 1976), and functional analysis (Meyer et. al. 1978), also known as direct utility assessment (Kocur et. al. 1982). A thorough comparison of these techniques is presented by Benjamin and Sen (1982a) and by Wind (1982).

In each of these techniques it is assumed that the choice between objects is made based on preference or utility for them. Object A is chosen over object B if the utility for object A is greater than the utility for object B. Furthermore, it is assumed that the utility of an object is a function of the partial utilities of the key characteristics of that object. This function may take any form, but is usually assumed to be polynomial or linear.

The use of conjoint techniques is not limited to evaluations of physical objects but may be applied to services. In a study of proposed elderly and handicapped services in Xenia, Ohio, (Louviere and Kocur 1979), a functional approach was used analyzing service attributes including transit fare, travel time, walk distance, type of service, and headway. The study used a measure of the propensity to use a service as the dependant variable in a regression analysis procedure. The study illustrated the validity of the approach and demonstrated significant effects of socio-demographics on preferences for service. The study, however, lacked a specific emphasis on the transportation handicapped, the nature of their handicap, and travel barriers they experience. The study reported in this paper adapts this procedure to a handicapped population.

Study Background

Data for the study were collected as an additional part of a study of the transportation handicapped. This was a study of a market segmentation approach which considered both travel needs and travel barriers; the results of the study are summarized in a report by Benjamin and Sen (1982b).

Sampling Frame

The total sample population for this survey consisted at 236 individuals. The sampling procedures combined four independent sample frames. Each frame represented an attempt to identify members of the handicapped population. Previous researchers had utilized similar sampling frames, but not in combination. A detailed analysis of each sample is available in Benjamin and Sen (1982b).

A random sample identified handicapped individuals by screening 5,000 respondents selected at random from the Greensboro telephone directory. Approximately 200 people indicated that they were eligible. A total of 54 interviews (22.9 percent of all responses) were completed using this sample method.

For an agency sample, public and private agencies serving handicapped clients were identified and the agency director or supervisor was contacted. Cooperating agencies were requested to provide a listing of potential survey respondents. A total of 96 interviews (40.7 percent) were obtained using this sample method.

GATE (Greensboro Area Transportation Express) is the principal service providing transportation to the elderly and handicapped in Greensboro. The GATE population comprised approximately 200 individuals over 18 years of age who rode GATE during the week of June 23-27, 1980. A total of 64 interviews (27.2 percent of all responses) were obtained through this sampling procedure. A smaller number of self-identified individuals were also included in the survey.

The purpose of combining these different sampling procedures was to guarantee representation of groups that are only sparsely present in the population of an urban area. In particular, those people who were confined to wheelchairs were not represented at all in the random sample.

Data Analyses

The Study Questionnaire

The conjoint questions were an additional part of the market segmentation questionnaire. Since the major questions were quite lengthy, the conjoint questions were asked at the end as optional aditional questions. As such only a subset of respondents answered the conjoint questions.

The questionnaire design was a Greco-Latin square (Winer 1971) which is an orthoganal design of factors with equal levels. Three factors at three levels each were used. The factors were round-trip fare, lead time (the interval between when call for service is placed and when vehicle will arrive) and hours of availability of service. The levels of each factor are presented in Table 1. A complete set of the three complementary Greco-Latin squares was used for the study

The services were presented randomly to each subject and the subject was asked to rate the service on an eleven point scale according to his estimate of how likely he was to use the service. Questions were asked separately for working or shopping trips (trips that are essential) and social or recreational trips (trips that are not essential). Subjects were presented with separate randomized services for each scenario. An example of a work/shopping questionnaire is presented in Figure 1.

Initial Results

A total of 236 subjects were interviewed as a result of the four different sampling techniques described in the sampling design section of this paper. Of these subjects, 108 completed the conjoint part of the questionnaire. Of these people, 15 were confined to wheelchairs, 19 used wheelchairs at least occasionally 79 had difficulty walking, 47 had problems seeing, 24 had problems hearing and 44 had tactile problems (problems with reaching and grasping). The typical respondent was a female; over the age of 60; was unemployed or was retired; had an annual income less than $5,000; and was not educated beyond high school. Approximately 55 percent of the sample was white.

Analysis of Preferences for All Groups

The analysis of preferences was a cross-sectional analysis and was completed using regression to estimate part utilities as coefficients in the following equation:

$$Y = B_O + {}_{ij}B_{i,j}X_{i,j}$$

where B_0 is a constant

$B_{i,j}$ is the part-utility of level j of factor i; i = 1,2,3 and j = 1,2,3

$X_{i,j}$ is a dummy variable representing the presence of level j of factor i in the service under consideration

and Y is the indicated preference for the service under consideration

Nine service evaluations were submitted to the regression analysis for each of the 108 respondents. Results of both the shopping scenario and social/recreational scenario are summarized in Table 1.

TABLE 1

Service Preferences for All Groups

Factor	*Shopping*			*Social/Recreational*		
I. Round Trip Cost	*Betz*[1]	*Std. Error(B)*	*F*	*Beta –*	*Std. Error(B)*	*F*
1. Free	0.49	0.25	223.5[2]	0.05	0.50	1.8
2. $1.00	0.33	0.25	98.0[2]	0.27	0.50	49.2
3. $4.00	0.00	——	——	0.00	——	——
II. Lead Time						
1. On demand	0.27	0.25	66.0[2]	-0.05	0.50	2.0
2. 2 Hours	0.09	0.25	7.5[2]	-0.01	0.50	0.0
3. 24 Hours	0.00	——	——	0.00	——	——
III. Availability						
1. 8 a.m.— 5 p.m.	-0.01	0.25	0.1	0.02	0.51	0.4
2. 6 a.m.— 10 p.m.	0.00	——	——	0.00	——	——
3. 24 Hours	0.02	0.35	0.5	-0.00	0.7	0.0

Shopping	Social/Recreational
Multiple R = 0.50	Multiple R = 0.26
Adjusted R^2 = 0.24	Adjusted R^2 = 0.06
F (6,927) = 5.05[2]	F (6,848) = 9.85[2]

[1] More positive coefficient indicates higher preference.

[2] Statistically significant at the .05 level.

FIGURE 1. Example of Conjoint Part of Questionnaire
Part A – Work Trips or Shopping Trips
Personal Preferences

Questionnaire I.D. ☐☐☐

Check One: ☐ Work ☐ Shop

	Round Trip Cost	Lead Time (Hours)	Time when Service is available	How Frequently You Might Use the Service											
				Never			Rarely		Half the Time			Usually		Always	
1	Free	On demand	6 a.m. – 10 p.m.	1	2	3	4	5	6	7	8	9	10	11	☐☐
2	$4.00	On demand	24 hours a day	1	2	3	4	5	6	7	8	9	10	11	☐☐
3	$1.00	On demand	8 a.m. – 5 p.m.	1	2	3	4	5	6	7	8	9	10	11	☐☐
4	$4.00	2 hours	8 a.m. – 5 p.m.	1	2	3	4	5	6	7	8	9	10	11	☐☐
5	$1.00	24 hours	24 hours a day	1	2	3	4	5	6	7	8	9	10	11	☐☐
6	$4.00	24 hours	6 a.m. – 10 p.m.	1	2	3	4	5	6	7	8	9	10	11	☐☐
7	Free	2 hours	24 hours a day	1	2	3	4	5	6	7	8	9	10	11	☐☐
8	Free	24 hours	8 a.m. – 5 p.m.	1	2	3	4	5	6	7	8	9	10	11	☐☐
9	$1.00	2 hours	6 a.m. – 10 p.m.	1	2	3	4	5	6	7	8	9	10	11	☐☐

The relative importance of each factor for the range of levels presented to the respondents is indicated by the relative size of the range of part-utilities as well as the F statistic for each coefficient. Table 1 illustrates that round trip for the group overall. This is confirmed by both the relative range of the part-utilities and the F statistic for the trip fare coefficients. Second most important is lead time. However, for social/recreational trips, lead time is not significant. For the overall group, time of availability is not significant, in fact it has a counterintuitive ranking for social/recreational trips. The R2 values and F statistics are higher for shopping trips than social/recreational trips, although both F statistics are significant. Since this is a cross-sectional analysis, the last result indicates larger consistency of preferences for shopping trips than recreational trips. This inconsistency was an indication that other variables, such as type of disability or socio-demographic variables (the background of the respondents) could account for the variation in preferences.

Analysis of Background Variables

Dummy variables indicating socio-demographics as well as personal disabilities were entered in a stepwise regression after the factor-level variables. The steps in which each variable was entered are: 1) age, 2) wheelchair confinement, 3) education, 4) difficulty walking, 5) hearing problems, 6) sight problems, 7) tactile problems, 8) household size, 9) marital status, 10) race, and 11) job status.

With the exception of age and education, the most important predictors are all disability-oriented variables. This is true despite the fact that disability groups are not mutually exclusive. The most important disability was wheelchair confinement (entered in step 2). This result is reasonable because this disability is perhaps the most restrictive and it leads to the greatest dependence on assistance for travel. The socio demographics age (step 1) and education (step 3) are also reasonable predictors since they are closely related to the level of travel activity of most people.

The importance of disability as a predictor of preference leads to the suggestion that groups of individuals who have similar disabilities also have similar service preferences.

Service Preferences for Disability Groups

Service preference part-utilities are listed in Table 2 along with function statistics for those confined to wheelchairs and all other respondents. The other respondents have similar preferences similar to those of the overall group discussed previously. However, when separated from the group, wheelchair-confined respondents demonstrated substantially different preferences.

For them, availability is the most important factor for shopping trips, fare second most important and lead time also has some bearing on service preference. This contrasts with preferences for recreational trips for which preferences are based on fare first and availability second.

TABLE 2

Service Preference for Wheelchair Confined People and All Other People

	Wheelchair Confined People		*All Other People*	
	Shopping	*Recreational*	*Shcpping*	*Recreational*
I. Factor				
1. Free	0.50	0.18	0.49	0.04
2. $1.00	0.30	0.45	0.33	0.26
3. $4.00	0.00	0.00	0.00	0.00
II. Lead Time				
1. Free	0.19	-0.04	0.26	-0.06
2. 2 Hours	0.13	-0.08	0.07	-0.00
3. 24 Hours	0.00	0.00	0.00	0.00
III. Availability				
1. 8 a.m.-5 p.m.	-0.47	0.21	-0.00	0.01
2. 6 a.m.-10 p.m.	0.00	0.00	0.00	0.00
3. 24 Hours	0.42	0.07	0.02	-0.01
R^2	0.34	0.20	0.26	0.06
F statistic	0.8[1]	5.18[1]	28.8[1]	5.26[1]
degrees of freedom	(6,126)	(6,128)	(8,540)	(6,471)

[1] F statistic is significant at the .05 level.

TABLE 3

Comparison of Preference for Shopping Trips by Handicap

Factor	*All Subjects*	*Wheelchair Confined*	*Use Wheelchair*	*Difficulty Walking*
I. Round Trip Cost				
1. Free	0.49	0.58	0.57	0.47
2. $1.00	0.33	0.30	0.34	0.32
3. $4.00	0.00	0.00	0.00	0.00
II. Lead Time				
1. On Demand	0.27	0.19	0.33	0.30
2. 2 Hours	0.04	0.13	0.19	0.12
3. 24 Hours	0.00	0.00	0.00	0.00
III. Availability				
1. 8 a.m.-5 p.m.	-0.01	-0.47	-0.04	-0.03
2. 6 a.m.-10 p.m.	0.00	0.00	0.00	0.00
3. 24 Hours	0.02	0.42	0.06	0.02
Numbers of subjects	108	15	19	79
R^2	0.24	0.34	0.33	0.24
F	50.5[1]	10.8[1]	13.29[1]	35.5[1]
degrees of freedom	(6,927)	(6,126)	(6,162)	(6,666)

[1] F statistic is signifcant at the .05 level.

TABLE 4

Comparison of Preference For Shopping Trips
By Persons With Sight, Hearing, Tactile Problems

Factor	*Sight Problems*	*Hearing Problems*	*Tactile Problems*
I. Round Trip Cost			
1. Free	0.51	0.45	0.50
2. $1.00	0.33	0.29	0.33
3. $4.00	0.00	0.00	0.00
II. Lead Time			
1. On Demand	0.21	0.25	0.22
2. 2 Hours	0.07	0.10	0.12
3. 24 Hours	0.00	0.00	0.00
III. Availability			
1. 8 a.m.-5 p.m.	-0.02	-0.03	-0.05
2. 6 a.m.-10 p.m.	0.00	0.00	0.00
3. 24 Hours	0.01	0.02	-0.04
Number of subjects	47	24	44
R^2	0.24	0.21	0.23
F	20.5[1]	8.65[1]	18.67[1]
degrees of freedom	(6,399)	(6,201)	(6,369)

The lowest fare (free) is less preferred than the next higher fare ($1.00). This is an indication that an ideal point exists for fare for service. An additional data set would be necessary to pinpoint the location of the ideal point. This difference in preference is related to the need for the service. If the service is life-sustaining this disabled group is more willing to accept assistance but for non-essential trips they would prefer to pay as much as they can.

It should also be noted that the R^2 value is higher for the more homogeneous wheelchair user groups than it is for the population and the R^2 values for the other groups are approximately equal to that of the population.

Table 3 & 4 contains analyses of all disability groups for shopping trips. Aside from those confined to wheelchairs, each group finds fare most important, lead time less important, and availability of little importance. In each case, free service is considered most preferable. Only wheelchair-confined people seem most concerned about availability. This consistency is due in part to the overlap between groups but is also an indication of the difference in reliance on assistance of the different groups.

Utilization of Preference Values for Service Design

One way to define comparable services for consumers is to find services which have the same total utility. This is found by summing the part-utilities for each level of each factor of the proposed service. Part-utilities for intermediate levels of factors (between levels evaluated directly in the questionnaire were estimated by interpolation.

Thus, if a service provided to the public has a fare of $.50 (round-trip fare of $1.00), is scheduled with a lead time of 30 minutes and is available from 6 a.m. to 10 p.m., the utility of an exact equivalent service for wheelchair confined persons is:

$$U = U_1(\$1.00) + U_2(1/2 \text{ hour}) + U_3(6\text{-}10) =$$

$$.30 + .17 + .00 = .47.$$

If, however, a dial-a-ride is suggested with the same utility but requiring a 24 hour lead time for calls, an equivalent service would require a compensatory improvement in some other service attribute. One way to estimate how much improvement compensates for the increased lead time is to reduce fare to a level that provides an equivalent total utility. By interpolation, the part-utility for a 40 cent round trip is .47. Total utility for a 40 cent service with 24 hour lead time available between 6 a.m. and 10 p.m. is thus 0.47 + 0.00 + 0.00 = .47 for which the total utility is exactly equivalent to the original service.

A fare reduction was not necessarily the only possibile An expansion of service hours would compensate for the increased lead time. (Calculation of this is left to the reader.)

This approach redefines equivalent service based on overall service characteristics as perceived by the consumer. Instead of matching services for general and special populations attribute by attribute, this approach gives some additional flexibility by permitting tradeoffs between attributes to allow for the individual nature of special services.

Concluding Remarks

In this study, a method of assessing consumer preferences is applied to the problem of designing services for the disabled population. Because the sample is small, it is not suggested that these results are transferrable. However, the validity of the approach is demonstrated. The transferrability of these results will be confirmed by additional studies at other locations over time.

The most difficult element of the approach is the questionnaire design. The research should also be cautioned on the sensitivity of these questions to the effects of different sampling and questioning procedures. Extensive pre-tests with focus groups were of great assistance in this study.

The analysis presented in this paper is only one possible use of the conjoint data set. Another analytical approach to conjoint questions is to analyze responses for individual respondents separately. Although cross-sectional analysis of individual responses leads to the same results as reported here, individual responses permit additional analyses that are helpful for planning. One example is that individual responses can be used to develop a posteriori service preference market segments. Another example of additional use of this data is to develop market simulations for proposed new services. These provide accurate forecasts of potential service utilization. A discussion of these approaches is presented in Benjamin and Sen (1982a).

Finally, the use of results should be made in the context of reasonable service levels within existing financial constraints. The use of panels to confirm analytical findings is helpful as realistic constraints are applied.

This approach is one way to develop service guidelines as well as to define equivalent service. It is presented with the hope that in a time of financial constraint we do not lose sight of our goals.

References

Anderson, N. Integration Theory Aplied to Cognitive Response and Attitude, San Diego, La Jolla: University of California, 1976.

Applied Resource Integration, Ltd. Results of Human Services Agency Transportation Survey. Memo Report No. 21 Boston: Applied Resource Integration, Ltd., January 1977.

Benjamin, J. and L. Sen (1982a), A Manual on Attitudinal Measurement Techniques, Office of University Research, USDOT, Washington, D.C. (available from NTIS).

Benjamin, J. and L. Sen (1982b), Market Segmentation of the Transportation Handicapped: An Assessment of Their Needs, Washington, UMTA, USDOT, also available from NTIS.

Green, Paul E. and Y. Wind. Multiattribute Decisions in Marketing: A Measurement Approach. Hinsdale, IL: Dryden Press, 1973.

Grey Advertising, Inc. Summary Report of Data from National Survey of Transportation Handicapped People. Washington: USDOT / UMTA, June 1978.

Johnson, R.M. "Trade-off Analysis of Consumer Values." Journal of Marketing Research, 1974, Vol. 11, pp. 121-127.

Kocur, G., T. Adler, W. Hyman, and B. Aunet, Guide to Forecasting Travel Demand with Direct Utility Assessment, Washington, D.C.: UMTA / USDOT and NTIS. 1982.

Louviere, J. and G. Kocur, An Analysis of User Cost and Service Trade-Offs in Transit and Paratransit Services. Washington, D.C.: USDOT / UMTA / RSPA / TSC and NTIS. 1979.

Meyer, R., Irwin Levin, Jordan Louviere, "Functional Analysis of Mode Choice," Transportation Research Record 673, pp. 1-7. 1978.

Michaels, Richard M., and N. Sue Wiler, Transportation Needs of the Mobility Limited. Prepared for the Northeastern Illinois Planning Commission. Evanston, IL: Northwestern University, Transportation Center, September 1974.

Wind, Y., Product Policy: Concepts, Methods and Strategy, Reading, MA: Addison—Wesley Publishing Company. 1982.

Winer, B.J., Statistical Principles in Experiental Design, New York: McGraw-Hill. 1971.

Julian Benjamin, Associate Professor of Economics and Research Associate, The Transportation Institute, North Carolina A & T University Greensboro, N.C. 27411.

EVALUATING THE BENEFITS OF SPECIAL TRANSPORT FOR ELDERLY AND DISABLED PERSONS: THIS CASE OF READIBUS.

S.R. Bowlby, A.M. Kirby, V. Swann

Introduction

This paper has several sections. In the first, we discuss the factors which have led in Britain to the growth of interest in user-responsive transportation for disabled and elderly people. Second, we outline some of the specifics which characterize transportation in the United Kingdom (U.K.), and which may distinguish conditions from those in other countries. Third, we outline some of the key characteristics of the ReadiBus service, a user-responsive service established in the town of Reading, England in 1981. Fourth, we provide profiles of users and non-users of the service, and in the fifth section we attempt to evaluate some of the many benefits generated by this type of service. We conclude by considering the methodological and policy implications of this research.

Background

There was little concerted attention paid to the travel needs of the less-mobile in the U.K. prior to the International Year of Disabled People. The growth of special transport systems in the U.K. since then has been considered in detail by Bailey (1984). As he indicates, the funding of such special schemes has now occurred in several locations, and in each instance volunteer bodies have been central to their evolution (Bailey, 1984: Figure 2). ReadiBus, operating in Reading, Berkshire (population c.131,000) is a pioneer example of this trend. It is not surprising that such special transport has been developed via voluntary effort, albeit backed by public money. Rising costs of welfare provision, coupled with increasing numbers and proportions of unemployed and elderly persons, have placed a burden upon a British government committed to restraining public expenditure. The response has been to transfer support from the state to voluntary organizations, a shift that has been in evidence in other welfare fields, such as housing (Kirby, 1985).

The Geographical Context

Although demand-responsive transportation has been attempted in affluent societies such as the USA and West Germany (Heraty, 1984), it is clear that it is also apposite in countries such as Britain where disposable income is lower and personal mobility is more constrained[1]. The position vis-a-vis transportation is outlined by Banister, who argues that although only 56 percent of households currently possess an automobile, public transportation is being streamlined in response to increasing costs, notably in rural areas (Banister, 1984). This means, in particular, that many elderly persons are losing their opportunities to travel, as services are reduced or even withdrawn.

The position vis-a-vis disabled people has also been in flux in policy terms in recent years, as traditional subsidies for personal mobility have been reevaluated; the emphasis has shifted somewhat: for example, from providing or funding individual vehicles to public vehicles, again as a result of the high costs of specially-designed transport for the disabled (Bowlby et al., 1983).

A key factor then in any analysis of the provision of transport for elderly and disabled people is that of finance, both public and private. Both of these potential groups of users are likely to have low disposable incomes. If representatives of either group are to have higher levels of personal mobility, it is clear that, in a country like Britain, it is not possible to depend upon either the generosity of friends and / or relatives with private vehicles (due to the relatively low availability of such opportunities), or the higher-cost alternatives such as taxis. As noted, public transportation is, in some areas, of declining importance, and a significant proportion of potential users is in any case unable to use buses (Hopkin, 1984). Nevertheless because of low car ownership levels, many people, notably women, are accustomed to and have confidence in bus transport—a factor which may encourage the use of special bus transport, where provided.

The ReadiBus Service

ReadiBus began operations in October 1981, using four 12 seater Mercedes vehicles employing tail-lifts.[2] The service was financed by a grant from the U.K. Department of Environment and a smaller grant from the Borough of Reading, and is operated by Reading Voluntary Services Council. Expenditure in 1982/3, the first full year of operation was 86,869 pounds Sterling (dollar

---

[1] The current social, economic and political situation within Britain is described in Short & Kirby (1984).

[2] The seating can be rearranged to accomodate up to 4 wheelchairs.

TABLE 1

ReadiBus fares: 1984

Distance	*Single*	*Return*
Under 1 mile	36 cents	67 cents
1 — 4 miles	61 cents	$1.10
Over 4 miles	79 cents	$1.52

Converted to $ equivalent, $1 = 0.81 pounds Sterling

TABLE 2

Trip purposes, ReadiBus and other modes[1]

Trip Purposes	*As proportion of all Readibus trip types*	*As proportion of all trip types by all modes*	*Importance of Readibus (see [2])*
Visiting Friends/ relatives (and hospital visiting)	29%	19%	A
Shopping	18%	18%	C
Entertainment/recreation	15%	17%	C
Medical	9%	12%	D
Personal business	9%	15%	D
Day centre/disabled clubs	7%	9%	D
ordinary clubs	6%	4%	B
Clubs—indeterminate	2%	3%	D
work/education	6%	4%	B
Total trip types	100% (n = 109)	100% (n = 313)	

[1] Modes employed include car and walking

[2] A = more than 50% of this trip type by Readibus
B = more than 40% but less than 50% of this trip type by Readibus
C = more than 30% but less than 40% of this trip type by Readibus
D = more than 20% but less than 30% of this trip type by Readibus

(**SOURCE**: questionnaire data).

equivalent, $106,000). The research on which we draw in this paper was a study of the take-up and impacts of the service on disabled and elderly people during the first eighteen months of its operation. Full details of our findings and approach are given in Bowlby et al (1984).

The service grew rapidly, until by September 1983 users had increased to 1,439[3]. The fares, which are shown in Table 1, are comparable with those charged on other forms of public transport; however, elderly (and disabled) people are given free bus travel, so for them the service is more expensive than travel on an ordinary bus.

The organizational details of the service are as follows. Potential users call a widely-publicized telephone number between 8 AM and 3 PM, and book journeys for the next day. Trips for any purpose are possible, although origins and destinations must be within the borough and a limited number of additional adjacent locations. Any individual who considers her or himself to have current problems in using other modes of transport is eligible, and may bring a companion. An escort service is available to assist any passenger with, for example, a shopping trip.

Approximately one quarter of trips are less than one mile, and less than 5 percent are greater than 4 miles. The largest single destination for trips is the Central Business District in Reading, although origins and destinations are scattered throughout the town. As Bailey observes, this basic geographical fact has dictated that ReadiBus, along with its various counterparts which have a similar organization, must face low ridership levels because it is impossible to program routings efficiently without complex computer assistance (Bailey 1984).

For the most part, trips are linked to non-work activities. As Table 2 indicates, most users are riding on ReadiBus to undertake entertainment or shopping trips to visit friends and relatives. These are, in fact, the kinds of trips that can most easily be arranged within the highly flexible schedules offered by ReadiBus. Only 6 percent of trips are related to employment or education and this reflects the impossibility of booking a regular time slot with the service. Frequent users must attempt to book their trips every day, and face in consequence the possibility of disappointment.

It is the booking service which has consistently received the greatest criticism from users and those who have tried the service but who have failed to become regular users. Below we examine in greater detail the profiles of these categories of users and non-users of the service.

Users and Non-users of ReadiBus

We may summarize the investigations of those who have taken advantage of, and those who have avoided ReadiBus, in the form of six generalised profiles, shown in Tables 3 and 4.[4]

Profile A is the group which has benefitted most markedly from the introduction of the service. Members are in the main elderly, and have increased their mobility since the inception of the service: in short, ReadiBus has revealed a latent demand for travel within this group. Because of this increased mobility, members of group A are generally enthusiatic about ReadiBus.

Members of group B conversely are far more critical of the service, and make use of it far less often. However, these individuals are also far more mobile, and have access to other forms of transport, notably private car and taxi.

---

[3] This total has continued to grow to over 1700 users by 1984.

[4] Full details of our various data sources, sampling frames and questionnaire procedures may be found in Bowlby et al (1984).

TABLE 3

Profiles of the three main groups of ReadiBus users.

Group	*Characteristics*	*Mobility*	*ReadiBus Use*
Profile A			
Largest of user groups; least critical of service. Now very dependent upon ReadiBus.	Elderly group generally over 70 years, usually single women. Correspondingly low income. Disablement generally related to frailty and/or arthritis.	Low: usually only 10 journeys per mounth	Approx. ⅔ of journeys usually for social visits and shopping trips
Profile B			
Little latent travel demand; generally critical of operational aspects of ReadiBus	Younger group (20-50); more usually couples living in owned accommodation with household car. Some severely disabled.	High, over 20 journeys per month. Wide variety of modes employed	Less than 15% of journeys usually for entertainment
Profile C			
Smallest group; highly dependent upon Readibus	Frequent users, of differing ages and with different trip purposes: employment, education, social visits. Some severely disabled.	Very high: 26—40 trips per month	Over ⅔ of journeys by ReadiBus

TABLE 4

Profiles of the three main groups of ReadiBus non-users

Group	*Characteristics*	*Mobility*	*ReadiBus Attitude*
Profile D			
Largest of the groups: indifferent rather than critical: little latent travel demand.	A group from late middle-age through to elderly. Relatively high income, two person households	High household car ownership; journey levels highly variable, but generally made by car	Service offers nothing to this group that personal resource cannot provide
Profile E			
Little latent demands due to severe disability	Relatively elderly group, frequently with rapidly advancing disability	Deteriorating health has reduced latent demand for travel by any mode: less than four trip types per month	Service offers nothing to this group due to their immobility
Pofile F			
Critical of ReadiBus but with latent travel demand	A wider range of ages, some with greater personal independence; generally less disabled than those in Profile E or users of Profile A	Generally able to walk a little and/or use bus with difficulty. Journey levels variable but higher than amongst Profile E	Critical of booking procedure and fare cost

Members of group C are the smallest in number, but constitute a group of people who make very frequent trips, - sometimes as many as 40 a month. Some individuals are in employment, some in education, and others make regular social visits. Representati of this group make the greatest use of ReadiBus, both as a proportion of all their trips and in absolute terms, as a number of trips per month.

In addition to examining the users of the service, studies were also made of non-users: i.e. those who are eligible to use the service but have not done so. once again, we have divided these individuals into three "ideal types." Of these, group D is the largest. Members are typically in the highest income brackets, and already have a complex pattern of interactions, typically involving household automobiles. Latent demand is thus very low, and members of this group do not perceive ReadiBus as in any way contributing to their travel needs.

Group E is similar in so far as members have little latent travel demand, although this reflects very different factors. These individuals are relatively elderly and are frequently experiencing rapidly advancing disabilities. Their inactivity—typically less than 4 trips per month—is thus a function of immobility, and ReadiBus once again does not appear as contributing to their travel needs.

The third and smallest group of non-users is heterogeneous in terms of age, although members are typically less disabled than representatives in other groups. They are however united in their dislike of the ReadiBus service, and are critical, both of the problems of booking trips, and of the fare structures: more emphasis is placed upon walking than riding by this age group. Although this was the smallest group that we identified within our sample, estimates indicate that this could ultimately include up to 1,000 elderly disabled people plus an unknown additional number of non-elderly persons.

These profiles indicate that there are individuals for whom ReadiBus has, in its current form, little to offer.

User and Non-user Benefits and Disbenefits

The benefits of a service can be represented in terms of an aggregated measure such as consumer surplus. Although some of the data needed to undertake is available such analysis there remain considerable reservations over both the reliability of the data and over aspects of the approach itself. In the light of these reservations we decided it was most appropriate for the purpose of policy evaluation to itemize, and evaluate individually, different sources of benefit. Therefore was selected a strategy which will emphasize the existence and the nature of a range of both quantitative and qualitative benefits. These accrue not only to users of the service but also to other affected individuals and groups. Table 5 indicates the range of potential benefits which can be considered. Further, both gross and net benefits were examined. For example, all users of the service expend scarce time and money both in making bookings and taking trips. In some cases a potential user may find these costs too great and become, or remain a non-user. This is why it was important also to interview non-users.

Using the typology in Table 5 as a framework we now briefly indicate what major benefits we identified and how we measured them. We interviewed disabled and elderly users, and collected recall information about their travel behaviour before becoming ReadiBus users in terms of 'trip-type''[7]. We found that approximately one fifth of the journeys made by users were 'new journeys'. For users without automobile access, a further 10 percent of journeys, although made before, were now dependent on ReadiBus, in the sense that they would cease to be made if the service were unavailable.

We also found that over one-quarter of ReadiBus trips had previously been made by taxi; given the large cost differentials involved (anything up to 6 times the cost), this clearly represents a major saving to users on low incomes. Only about 1 percent of all users were in employment. However, we would expect that over a longer period the service could allow people with progressive disabilities to remain in employment. For this to occur on any large scale, however, changes in booking procedures will be necessary[6]. Our questionnaire also included open-ended questions about the service and users' reactions to it. Replies to these questions indicated that many users found the service gave them enhanced independence and quality of life. Moreover, a high proportion of the new journeys made were to visit friends, indicating improved social integration.

Despite the existence of these user benefits, interview with both elderly and younger disabled non-users indicated that for some the financial costs of using the service outweighed its advantages. For others, time and effort taken in booking were a powerful disincentive to use. Amongst elderly people it is estimated that ReadiBus only served about half of those who were eligible to use the service, interested in travelling, and without adequate alternative means of transport. Thus, although the service is able to provide positive net benefits to some eligible travellers it is not reaching all those in need.

TABLE 5

Estimate of cost per trip; Financial year 1982/83, including estimates or vehicle and computer costs.

Item	*Cost in Pounds*	*% of costs ****
Employees	52662	61
Premises	35	0
Establishment	5653	7
Transport	17362	20
Vehicle depreciation*	8480	10
Computer depreciation**	2667	3
Total	86859	
Less Revenue	6890	
Total	79969	
Trips in year	18548	
Costs per trip	4.31 pounds Sterling	

* Based on capital costs of 42,400 pounds over five years
** Based on capital costs of 8,000 pounds over three years
*** Rounded to nearest whole number

A service such as ReadiBus may also provide benefits to groups other than users. One such group is that of the "carers", i.e. those involved in assisting disabled and elderly people either in a voluntary capacity (relatives and friends) or in a paid capacity (home help visitors, doctors, etc). Since time and funds were limited, we were only able to examine benefits to these groups indirectly, through our interviews with ReadiBus users. We asked whether the frequency of visits by paid and unpaid helpers had changed. The monitoring period was too short to allow many changes to have occured, but it is likely that increased mobility for disabled people implies a more efficient use of home helps' time and there is some evidence of a reduced dependence upon relatives and friends.

The service may also provide public benefits through reducing the costs of domiciliary or residential care. Here again our monitoring period was too short to allow us to investigate such benefits. They are, nevertheless, in principle, possible to estimate and to compare with the public subsidy required to run the service. We have, however, in Table 5 included one benefit which is very difficult to measure, but which we consider important—greater visibility and recognition of the needs of disabled people.

The brief outline of study results indicates three main issues. First, in order to fully identify and assess the benefits of such a service a long monitoring period is necessary—ideally a period of 5-10 years is required. In addition, data should be collected before a service is implemented so that its impacts can be more fully and precisely assessed.

Second, benefits (and disbenefits) require a broad specification and that impacts on groups such as carers and the tax paying public should not be ignored. Interviews with carers and information on their activities and feelings should be included in any complete monitoring exercise. Data on non-users is also necessary if the extent of benefits to disabled and elderly people is to be assessed.

---

[7] A trip-type is a journey to a particular location for a particular purpose during a specified period. Visit(s) to the town centre to shop during a week would be one trip type.

[6] ReadiBus operators are currently experimenting with allowing advance booking of trips.

Third, collection of data on qualitative as well as quantitative benefits and costs requires the use of unstructured- or semi-structured interviews. Moreover, such interviews may ease the problems of eliciting critical comments from users fearful of losing the only service they have, whatever its faults.

Conclusions

Here we should be emphasized some methodological issues rather than further specific policy recommendations. Throughout this paper, has been made reference to the wide implications of this kind of transport innovation, and the importance of evaluating the full implications of any policy initiative in this field should be stressed. Thus a policy development for the minority will also have implications for the majority. In addition, emphasis should be placed on the importance of increasing the visibility of disabled persons and their needs, particularly in a society where these needs have traditionally been masked.

Second, transport innovations only make sense if they are linked with other policy developments. For example, it is of little benefit to riders if they are deposited in central city areas in which wheelchair access has not been provided or, more fundamentally, if they lack sufficient disposable income to allow them to buy goods on a shopping trip.

Third, the advent of a service like ReadiBus must also be tied explicitly to the planning and operation of other transport services. At present, because of the booking procedure and shortcomings in long-distance services ReadiBus is not effectively tied in to other, long-distance modes.[7] Furthermore it is not included, as it should be, within current local transport planning procedures.

In short, a system like ReadiBus cannot be evaluated fully without an examination being made of the many and varied impacts and connections that such a service involves. More over, these impacts cannot be properly identified and monitored unless they are monitored over the long term.

References

Bailey, J.M. (1984) Underlying Factors in the Development of Demand—Responsive Transport in Britain. Paper presented at the Third International Conference on Mobility and Transport of Elderly and Handicapped Persons, Orlando, Florida, October 29-31, 1984. Preprints of papers, Florida State University, Tallahassee, Florida.

Banister, D. (1984) Policies for Public Transport. In Short, J.R. and Kirby, A.M., Eds. (1984), The Human Geography of Contemporary Britain, London: Macmillan, pp. 115-125. Bowlby, S.R., Kirby, A.M. and Swann, V. (1983) Mobility Problems of the Disabled, Cities 1 (2): 117-119.

Bowlby, S.R., Kirby, A.M. and Swann, V. (1984) Use of Demand Responsive Transport for Disabled People: The ReadiBus Example. Department of the Environment, Department of Transport, Report, Transport and Road Research Laboratory, Crowthorne, Berkshire.

Heraty, M. (1984), Monitoring Demand-Responsive Transport for Disabled People: The ReadiBus Example. Department of the Environment Department of Transport, Report SR828, Transport and Road Research Laboratory, Crowthorne, Berkshire.

Hopkin, J.M. (1984) Estimating the Demand for Special Transport for Disabled People in Great Britain. Paper presented at the Third International Conference on Mobility and Transport of Elderly and Handicapped Persons, Orlando, Florida, October 29-31, 1984. Preprints Papers, Florida State University, Tallahassee, Florida.

Kirby, A.M. (1985) Voluntarism and The State, Tijdschrift voor sociale et economische geografie, in press.

Short, J.R. and Kirby, A.M. (1984) The Human Geography of Contemporary Britain, London: Macmillan.

Sophia R. Bowlby and Valerie Swann, Geography Department, Reading University, Reading, RG6 2AB, England. Andrew M. Kirby, Geography Department, University of Colorado, Boulder, CO 80309.

---

[7] As footnote 6 indicates, modifications to the booking system now being tried may improve this situation.

COST ANALYSIS TECHNIQUES FOR TRANSPORTATION SYSTEMS SERVING THE ELDERLY

Jon E. Burkhardt, Sue F. Knapp, and Mark C. Wozny

The transportation problems of older Americans have been the focus of a great deal of attention over the past decade, but not all subtopics have been thoroughly covered. We studied cost analysis techniques because previous research (Birch and David Associates, 1982, CTR 1981; Wozny, 1982) demonstrated a fundamental lack of knowledge concerning the costs of services provided to the elderly. Indeed, not only were specific dollar costs unknown, but basic cost analysis principles were not being followed. The problems observed in the literature included:

- service costs were compared from different years without standardizing to a base year,
- cost comparisons were often based on varying definitions of service,
- measures of units of service were inconsistent,
- it was often unclear which costs were included,
- there was no standardization of quality of service, and
- the comparisons often combined and confused costs of production and costs of consumption.

Initial interests in fairly straightforward questions—what are the costs of services for the elderly? and what are the cost differences between serving the rural and urban elderly? —thus lead to a broader and more useful investigation.

A research project funded by the Administration on Aging (Wozny et al, 1984) led to the development of standardized methodology for determining the costs of services for the elderly. This methodology corrected the deficiences noted above. It provides a resource-based approach which assigns dollar values to all inputs required to deliver services, whether or not such expenses are included in an agency's budget or in their list of expenditures. Adopting this more comprehensive approach would obviously involve a change in thinking for many agencies. If this hurdle can be surmounted, the benefits for better decision-making are substantial: local providers can get a clearer picture of their true costs, factors that vary from region to region or site to site can be better understood, and standards for comparisons to other systems can be developed. All these factors lead to more informed management decisions about service attributes and to greater cost-effectiveness. Specific instructions for applying this methodology are presented in a cost analysis manual. (Burkhardt et al, 1984)

In this study, the services costed in detail were transporation and in-home services. These two services are vital to older Americans and they have been recognized as priority services by the Administration on Aging. Transportation services provided to the elderly by agencies contacted for this study are generally provided separately from other transportation services by human service organizations. Among the 49 transportation providers studied, the average elderly transportation system has three vehicles and provides most of its service on an advance reservation basis. Door-to-door service is common. For the 56 in-home service providers studied, the services most often provided are personal care, homemaker services, and nursing care, using personnel of various skill levels, depending on the service. Federal funds account for nearly 60 percent of the annual income of both the transportation and in-home providers.

The comprehensive cost analysis framework examines human services costs in terms of three dimensions: the service being costed in terms of requisite activities and functions, the resources necessary to provide the service, and the costs of the resources. This approach develops service costs in terms of the actual amount of resources needed to deliver a service unit and the costs of those resources as determined by a particular setting. Because this approach works by combining very detailed individual cost elements, called parameters, the overall costing methodology is known as "parametric cost modeling." It can be used to estimate the unit cost of a service using simple equations. The beauty of this methodology is that, while they are simple, the equations include all costs of the service. the basic parametric cost model developed for this study is:

Total Service Costs = (Service Operating Costs + Service Administrative Costs + Service Capital) × (Agency Administrative Expense Factor).

The total cost of a particular service is calculated by estimating the service operating costs (e.g., wages for persons providing nursing services) and adding to them the cost of administering that service (e.g., wages for supervising the nurses). The capital costs attributable to that service (e.g., vehicles for transporting clients) are then added in. This subtotal represents all program costs associated with that particular service. The general agency administrative factor, which represents that portion of the agency's total administrative costs that should be allocated to that one service program (sometimes known as the agency's indirect or overhead rate), is then multiplied by the program costs to arrive at a total cost. Both program and general agency administrative costs are expressed as ratios (decimal equivalents) of the administrative costs to operating or program costs.

This study recorded or estimated values for all of the resources used to produce a service, whether those resources were paid, donated, or volunteered. The calculation of total resource costs is not influenced at all by the extent to which these costs are offset by program income, grants, contributions, or other income-generating sources. After a total cost analysis is performed, a comprehensive financial plan can be drawn up showing how the costs will be covered. Funding considerations are thus subsequent to, and beyond the scope of, the work described here.

Data Base and Methodology

The first phase of this work involved an extensive review of the literature on costs of transportation and in-home services. In the second phase, data were collected by a review of documents and costs accounts plus very detailed interviews with 110 service providers in 16 Planning and Service Areas (PSAs)[1] around the country. The 16 PSAs were selected by the University of Michigan to be representative of the 256 PSAs in the U.S. where both transportation and in-home services were offered to the elderly by service providers who were receiving some Title III funds.[2] In order to observe the effects of various factors on the costs of services, sampling controls were provided for four U.S. Census regions, four levels of urbanization, the size of the PSA, and the organizational framework of the Area Agency on Aging in each PSA.

The study team first contacted the Area Agency on Aging in each of the 16 PSAs in order to obtain a complete list of service providers. Personal contacts were then made with all service providers in each of the 16 PSAs who had some Title III funding to provide transportation or in-home services. In-depth interviews were conducted in the offices of the service providers with executive directors or program administrators. These interviews ranged from one to three hours in length, and involved inspections of accounting ledgers, enumerations of space and equipment, and verifications of various rates and costs. The completed data collection instrument resulting from each contact thus contained extremely detailed reports and observations on personnel and their activities, space, equipment, and administrative procedures. Since the interviews were performed in 1983, the data collected represent 1982 fiscal year costs and performance figures. Highlights of selected findings are summarized below.

Findings Transportation Costs

The sample of 54 transportation providers produced 65 completed data collection instruments about transportation services to the elderly. The 65 data instruments described services obtained in three different ways: 49 agencies directly provided transportation services (that is, they ran their own transportation operations); nine purchased services from other providers; and seven agencies reimbursed their staff or agency volunteers for providing services with their own vehicles. Nine agencies obtained services in more than one way. The detailed costs analyses were performed only for those 49 agencies providing transportation directly.

Although the 49 transportation agencies were alike in purpose and mode that is, a general mixture of fixed route and demand-responsive services, they differed substantially on other characteristics. Table 1 provides a sense of the basic dimension of these systems for use as benchmarks against which to measure other systems. In addition to those characteristics of the provider agencies shown in Table 1, six percent of the agencies (3 providers) charged for their services and the remainder did not. Of those who did not charge, 45 percent (21) had a suggested contribution and the remainder of that group did not.

TABLE 1

Characteristics of Transportation Systems Serving the Elderly

(Base: 49 agencies directly providing services)

Characteristic	*Mean*	*Median*	*Standard Deviation*
Trips per Month	2,725	1,881	3,131
Number of Vehicles	5.8	3	6.1
Vehicle Miles per Month	6,667	4,092	6,419
Hours of Service per Week	37	40	10.6
Vehicles Hours of Service per Month	963	480	1192.3

In order to understand transportation costs, it is necessary to differentiate between costs to make a mile of transportation service available to clients (production costs: costs per mile, per hour) from costs to supply those trips actually taken by elderly clients (consumption costs: for example, costs per trip). The obvious link between the two is how many trips are actually taken for each mile of service provided (expressed as the total number of trips taken by all clients served during a month divided by the total number of miles driven by all the vehicles of the systems during that month.)

---

[1] A PSA is a geographic service area designated under Title III of the Older Americans Act of 1965, as amended. Almost 680 PSAs now exist. Within each PSA, services to the elderly are administered and coordinated by an Area Agency on Aging. Title III, refers to Title III of the Older Americans Act of 1965, as Amended, Grants for State and Community Programs.

[2] The information source for identifying the 256 PSAs which met these criteria was the 1981 National Data Base on Aging Survey conducted by the National Association of State Units on Aging and the National Association of Area Agencies on Aging.

Three transportation production rates were considered in the study: 1) trips per vehicle mile, 2) trips per hour of vehicle availability and 3) miles per hour of vehicle availability. Trips per mile averaged .437, while trips per available vehicle hour and miles per available vehicle hour average 3.88 and 9.80 respectively.

As expected, trips per vehicle mile are greater in urban areas than in rural areas (31.1 percent greater, at .379 in rural areas and .497 in urban areas). The trips per available vehicle hour are 41 percent greater in urban areas, and miles per available vehicle hour are 26 percent greater in urban areas.

There is a strong relationship between urban/rural and cost per mile, with the cost per mile for both high and low quality services considerably higher in urban areas. The findings are more mixed with regard to cost per trip. For high quality services, the cost per mile is significantly greater in urban areas. However, for low quality services, the difference between the costs per trip in urban areas and rural areas is not significant.

The most important measure of service costs is cost per trip since this measures the costs of each unit of transportation service actually consumed by an elderly client.

TABLE 2

Unit Costs of Transportation Consumed By Urban/Rural Classification (1982 dollars)

Area	*Service Quality*	*Average Cost Per Trip*	*Range of Costs per Trip*
Rural	Low Quality	$6.57	$1.59[a]—$13.76[b]
	High Quality	4.60	3.30 — 7.83
	Average Rural	5.55	1.59 — 13.76
Urban	Low Quality	$5.86	$ .73[a]—$14.47[b]
	High Quality	6.94	2.11 — 12.06
	Average Urban	6.35	.73 — 14.47
Average (all 49 providers)		$5.92	$ .73 —$14.47

[a] These are systems with unusually high numbers of trips per mile or per hour.

[b] These are systems with unusually low numbers of trips per mile or per hour.

The cost per trip for transportation services also varies by agency type. The classification of service providers in the study sample by agency type and the related differences in cost per trip are shown in Table 3. Trips by public agencies cost approximately 19 percent more than trips by private non profit agencies. Trips by single-purpose agencies cost more than trips by agencies with other management types. Trips by Community Action Agencies and government-based agencies cost more than those by aging services organizations or senior centers.

TABLE 3

Unit Costs of Transportation Consumed by Agency Type

Agency Type	*Number of Agencies*	*Average Cost Per Trip (1982 dllars)*
Organization Type		
private non-profit	38	$5.67
public	11	6.75
Management		
single-purpose agency	12	$6.44
independent unit with central planning unit	6	5.17
part of consolidated multi-purpose agency	31	5.89
Agency Base[a]		
aging services agency[b]	14	$5.43
community action agency	10	6.88
city or county government[c]	6	6.29
senior center	14	4.84
others	5	6.69
Average Cost (all 49 providers)		*$5.92*

[a] Agencies were classified into mutually exclusive agency base categories as follows: Aging services agencies were agencies planning, administering, or providing services to the elderly. In this sample, 11 aging services agencies were private non-profit organizations and three were public agencies. Government agencies performed the same functions through public agencies for the elderly and other clients as well. Community action agencies were those organizations established to serve the poor, some of whom are elderly. All ten community action agencies contacted in this study were private non-profit organizations. Providers of limited services to the elderly from one specific location were classified as senior centers.

[b] In this sample, one of the 14 aging service agencies directly providing transportation services was an Area Agency on Aging.

[c] In this sample, two of the six county government agencies directly providing transportation services were Area Agencies on Aging.

From previous research it was suspectad that, if quality[3] were taken into account, the cost per trip would be higher in rural areas or at least comparable to the cost per trip in urban areas. The data from this study show some urban/rural differences in cost per trip among providers of different qualities of transportation service, although none were statistically significant. For low quality services, the cost per trip is 12 percent higher in rural areas. For high quality services, the cost per trip is 51 percent higher in urban areas. Overall, the cost per trip is 14 percent higher in urban areas. Table 2 presents unit consumption costs for transportation in urban and rural areas.

---

[3] To define quality of transportation services, this study combined attributes describing coverage of the service area with service descriptors such as total hours of operation each week; whether special labor intensive services are offered to elderly riders; number of training courses taken by drivers; whether all trip requests are met; whether the agency has back-up vehicles; and advance reservation time required. A standardized score was developed to rank all providers from high quality to low quality.

Urban/Rural Cost Differences

There are overall differences in the costs of services to the elderly that reflect the service provider's locale. Sometimes these differences were due to the costs of basic service inputs, such as labor hours; sometimes they were due to particular practices, such as the tendency for larger offices for in-home providers in urban areas; and sometimes they were due to consumption patterns of the elderly being served. These factors are summarized in Table 4.

The overall pattern that emerges is one of higher transportation costs in urban areas. Most transportation costs—including space costs, administrative wages, direct service labor, maintenance, and licensing—were higher in urban areas. Although service consumption was higher in urban areas, this did not offset the production cost differential, and all unit costs were higher in urban areas: cost per mile, cost per trip, and cost per vehicle hour.

Table 4

Summary of Cost Differences for Transportation Services in Rural and Urban Areas

Cost Factor	*Rural*		*Urban*
Administrative Costs:			
Overall Administrative Rates			
General	———		———
Transportation			Higher
Space Costs			
Rent per Square Foot			Higher
Other Space Costs	———	Same	———
Equipment	———	Same	———
Other Administrative Costs	———	Same	———
Administrative Labor			
Wage Rates			Higher
Fringe Benefit Rates	———	Same	———
Direct Costs:			
Operating Labor			
Wage Rates			Higher
Fringe Benefit Rates	Higher		
Fuel and Oil	———	Same	———
Maintenance			Higher
Insurance	Higher		
License and Registration			Higher
Unit Costs:			
Cost Per Mile			Higher
Cost Per Trip			Higher
Cost Per Vehicle Hour Available			Higher

SOURCE: 1983 survey conducted by the Institute for Economic and Social Measurements, Inc. of 49 transportation providers serving the elderly. (Wozny et al, Sept. 1984)

Administrative Costs

Labor costs are considerably greater in urban areas due to higher hourly wage rates. Fringe benefit rates do not vary between urban and rural areas. While the amount of office space used for administration do not vary between rural and urban areas, space costs are greater in urban areas due to the fact that rents in urban areas are almost double. Office equipment costs and other administrative costs also do not vary with the urban/rural nature of an area.

The general administrative expense rates averaged about 21.5 percent and do not vary considerably between urban/rural areas even with higher rent and labor costs in urban areas. General administrative rates do vary by the type of agency with single purpose agencies and independent units with central planning units having higher rates than consolidated multi-purpose agencies. Also, aging service agencies have higher rates than other organizations However, given the small number of cases in each agency category, these variations were not statistically valid.

Transportation administrative expense rates average around 35.2 percent. While they are not highly correlated with the urban/rural nature of an area, transportation administrative expense rates are slightly greater in urban areas. As with general administrative rates, transportation administrative expense rates also vary with the type of agency operating the service. However, in this case, the governmental agencies and service centers have higher rates than aging services or community action agencies. Since the reverse is true for general administrative rates, it may be that a tradeoff is being made in agencies between what is called general or transportation administration.

Operating Costs

Transportation operating costs are separated into three categories depending on the output measures which effect cost:

1. vehicle miles
2. hours of vehicle availability
3. number of vehicles

Operating costs dependent on vehicle miles include fuel and oil maintenance costs. Urban areas have slightly higher costs per mile in this category. Data in the study indicate that fuel/oil costs do not vary by urban/rural areas; rather, they vary considerably by vehicle type (larger vehicles consume more fuel per mile). Fuel and oil costs average $.165 per mile. Vehicle maintenance costs vary by both urban/rural area and by vehicle type, with urban areas and larger vehicles having higher maintenance costs per mile.

Operating costs dependent on vehicle hours include driver and dispatcher wages and fringe benefits. Urban areas have appreciably higher costs in this category. While the ratio of paid driver hours to vehicle hours available is slightly lower in urban areas, ratio of dispatcher hours to driver hours is considerably higher. In addition, even though fringe benefits rates are higher in rural areas this is probably due to the fact that wage rates for both driver and dispatcher are much higher in urban areas.

Operating costs dependent on the number of vehicles being operated include vehicle insurance, license and registration and vehicle storage costs. Both insurance costs and registration costs per vehicle are higher in urban areas.

Unit Costs and Production Rates

Differences in the above costs translate into higher costs to produce a unit of service output (a mile or hour of service) in urban areas. The cost per mile of service is over 50 percent greater in urban areas and the cost per hour of vehicle availability is almost 14 percent greater in urban areas.

As expected, production rates are also higher in urban areas due to higher population densities. Trips per vehicle mile are 31 percent greater; trips per available vehicle hour are 41 percent greater and miles per available vehicle hour are 26 percent greater in urban areas.

This brings us to the most important service unit cost—cost per trip. Data from this study indicate that even though production rates are higher in urban areas, this does not totally offset higher unit production costs. Thus, the overall cost per trip is 13 percent higher in urban areas; $6.35 per trip in urban areas as compared to $5.55 per trip in rural areas.

Conclusion

The research project described developed a resource-based cost analysis methodology to:

1. Document and analyze existing transportation services costs, and

2. Provide a basis for a hands-on cost analysis manual for use by service providers. The formal cost structure presented can be used by a wide variety of agencies to establish their own true costs of many kinds of services, including the transportation services dicussed here.

Special attention was paid to urban/rural cost differentials. It was expected that overall per trip costs in urban and rural areas would be similar despite large differences in individual cost components. It was believed that the larger urban salaries would be offset by the greater distances traveled per trip in rural areas. To some extent, this was true, but trips for the elderly in urban areas still cost one-seventh more than trips for the elderly in rural areas.

References

Birch and David Associates, Service Provider Financial Management and Accounting. Prepared for the Administration on Aging, U.S. Department of Health and Human Services, Washington D.C., September 1982.

Jon E. Burkhardt, Sue F. Knapp, Mark C. Wozny, The Cost of Services to the Elderly: A Manual for the Aging Network, prepared by the Institute for Economic and Social Measurement, Inc. for the Administration on Aging and the Institute for Social Research of the University of Michigan, November 1984.

Center for Transportation Research (CTR), Cost Analysis for Social Service Agency Transportation Providers. Prepared by University of Texas at Austin for U.S. Department of Transportation, January, 1981;

Mark C. Wozny, Evaluation of Differences in Needs and Service Programs Between the Rural and Urban Elderly, prepared by Ecosometrics, Incorporated for the Administration on Aging, U.S. Department of Health and Human Services, April 1982

Mark C. Wozny, Sue F. Knapp, Jon E. Burkhardt, et al., The Cost of Services to the Elderly: A Resource-Based Approach to Cost Analysis, prepared by the Institute for Economic and Social Measurements, Inc. for the Administration on Aging and the Institute for Social Research of the University of Michigan under Grant No. 90-A-1279, September 1984.

Jon E. Burkhardt is Vice-President, Sue F. Knapp and Mark C. Wozny are Senior Associates, Ecosometrics Inc., Bethesda, Maryland 20814.

CRASH PROTECTION OF CHILDREN, THE ELDERLY AND THE HANDICAPPED AND THE DESIGN OF INFLATABLE COMPARTMENTALIZED CONTROLLED DEFORMATION PROTECTIVE SYSTEMS FOR THEM

by Carl C. Clark

Introduction

This paper presents designs for the transportation crash protection of children, the elderly, and the handicapped, who share possibly decreased neuromuscular control, bone strength, and local tissue load tolerance in comparison to healthy young adults. The designs utilize inflatable compartmentalized systems for load distribution and reduction. A design of an inflatable protective system for the elderly hip, often broken in a fall, is presented. These designs have not yet been built.

(As a brief editorial note, given the substantial number of references, for space reasons these will be cited sequentially by numbers in parentheses rather than by author's name as would normally be the case.)

Crash Protection for Adults and the Elderly

Adult crash protection, which includes but does not separately distinguish crash protection for the elderly, is specified in Federal Motor Vehicle Safety Standard (FMVSS) 208 (1), with harness specifications in FMVSS 209 and attachment specifications in FMVSS 210. No special precautions are mandated for the elderly, although research continues in showing the decreasing bone strength with age, and hence the greater number of rib, sternum, and clavicle fractures produced by belts or other contact forces in crashes as age increases For example, based on cadaver data (2), in a 30 mph frontal barrier crash, a 20 year old adult male would be expected to have two or three thoracic fractures, usually under the shoulder belt. A 60 year old male might have 15 thoracic fractures. Studies of road accidents of car occupants wearing lap and shoulder belts (3, 4, 5) do not indicate so many thoracic fractures due to shoulder belt loads, for living car occupants of comparable age as opposed to cadavers in sled tests. However, some level of decreasing bone strength with age is generally accepted.

Crash loads may be more severe than the 30 mph barrier crash test condition of the FMVSS 208 standard (and many others of our standards). Indeed, about half of the car occupant fatalities occur with a crash change of velocity ("delta V") of more than 30 mph (6). The 30 mph delta V design condition for even the belt restraint must prevent death, but can produce a significant number of serious injuries (Abbreviated Injury Scale or AIS = 3) (4). NHTSA standards are not yet set to prevent injury under all reasonably expected conditions of use, as safety standards are intended to do in most other fields (7).

The elderly should be particularly careful to use all available crash protection, especially an airbag with a lap and shoulder belt as well, select the safer cars (8), which are generally but not always the larger cars, and drive particularly carefully. The elderly should encourage the availability of airbags, which provide a better chest and head load distribution. As of December, 1984 these were available only in certain Mercedes Benz cars.

Crash Protection for the Handicapped

The handicapped, often with reduced neuromuscular control, bone strength, and local tissue load tolerance, and sometimes with special braces or casts, are in particular jeopardy in motor vehicle crashes. Yet the standards for their protection in crashes are still rudimentary or non-existent. As an example, FMVSS 222, school bus passenger seating and crash protection, excludes "a seat installed to accomodate handicapped or convalescent passengers as evidenced by orientation of the seat in a direction that is more than 45 degrees to the left or right of the longitudinal centerline of the vehicle." As a consequence, a great many makeshift devices have been developed or used by the local school or transportation group, more to retain the handicapped person (or at least his/her wheelchair) in place during normal driving loads than to protect against crash loads. The NHTSA has not proceeded with writing standards for crash protection of the handicapped.

The Education for All Handicapped Children Act of 1975 (9) was passed to assure that handicapped children would have access to public education—by requiring schools to provide transportation and class access for these children -"mainstreaming" them instead of leaving them as a low priority social problem for others to deal with. With the obvious reduced neuromuscular control of body posture of cerebral palsy children, for example, body support during normal driving is needed; support for everyone in a crash is a less obvious need.

Similarly, the needs of the handicapped in driving their own vehicles are more obvious than their needs when they get in a crash. Many of the handicapped are already on public funds; the costs of injuries are also largely public funds, although generally from different budgets or even agencies. The short term "savings" of ignoring potential accidents could become losses of public funds if crash protection is not part of the expenditure

The handicapped adult has inadequate protection as a car passenger or driver. As a car passenger, he or she cannot yet get an airbag system. One can get a physician's note excusing use of belt systems which may be uncomfortable or dangerous, but this will not protect one in a crash. It is to deal with this problem that the conceptual airbag designs at the end of this paper are offered.

Early Airbag Crash Protection Work

Several people independently invented deformable airbags or inflated airpads or aircushions for the crash protection of humans. The author was one of these, but not the first. Most of the others described the idea, or made sketches, or even got patents, (initially unknown to the author) but were not able to demonstrate the feasibility of the airbag protection concept, which in the period prior to 1964 was often ridiculed. The author was fortunate enough to work for the Martin Company, Baltimore Division, which encouraged some experimental work on the author's part before seeking outside funding. In 1962, he made the first public (and perhaps private) dummy and human crash tests simulating a vehicle with an airbag protective system.

We were initially concerned with protecting astronauts in spacecraft landings (10,11), and so experimented with full length "couch" airbag systems. After our inital human experiments crashing in airbags, the Martin Company, through our efforts, received the first U.S. government airbag restraint contract (NASW-877, January, 1964), from the National Aeronautics and Space Administration (NASA), to design and test human airbag protection systems, initially for astronauts but later amended to cover aircraft and ground transportation vehicles. As this work progressed, (12, 13), we recognized that crash protection was more pressingly needed in aircraft, and particularly in motor vehicles. Four addenda to the NASA contract were awarded to allow us to consider protection for these other means of transportation. We modified the airbags for the seated position, and built the first "airseat" inflated seat structures to provide, by adjusting pressure, controllably deformable protection behind as well as in front of the occupant. We tested or arranged with NASA and other crash testing programs, to test the airbags and /or airseats for the first public (and possibly the first public or private) crashes with airbag restraints in a spacecraft simulator, a large commercial aircraft (a DC-7 experimentally crashed by the Aviation Safety Engineering and Research—AvSER—Group of the Flight Safety Foundation in Phoenix on April 24, 1964), two small military aircraft, a helicopter, a passenger car (a right front passenger pre-inflated airbag with a dummy in a car which hit the back of a school bus at 60 mph on April 16, 1966), and school buses (the last two in cooperation with the vehicle crashes of Derwyn Severy, Institute of Transportation and Traffic Engineering, University of California, Los Angeles). We designed the first "safety car" with airbag restraints. In this period, the technical details of the work of the automobile industry and suppliers of airbag protective systems, still only partially published, was then kept secret, although the fact that the auto companies had worked on airbags and found all kinds of problems was discussed in response to our work. We do not yet know whether the industry crash tested an automobile with a dummy using an airbag restraint prior to our airbag automobile crash of April 16, 1966. Our work set the climate for the automobile companies and others to take a more intense and public look at airbag protection in response to questions from public officials and others. Our work was the first to show the possible protection from airbags once inflated; the work of others in developing the sensor and rapid inflation technology was of course essential to the present commercial development and public use of airbag systems.

It is my hypothesis that multi-layered, multicompartmented inflatable systems can provide the best restraint part of the crash protection system for children, the elderly, and the handicapped, with more or less of the system being inflated during normal driving depending on the magnitude of postural instability or the need of the occupant to relax.

Designs for Inflatable Compartmentalized Protection Systems

Hugh Dehaven, the "father" of crash protection studies, in the classic work indicating that humans could tolerate far greater crash loads if the loads were well distributed (14), reports human falls with moderate injury into soft dirt from heights up to 150 feet. John Stapp (15) further analysed these and related cases. In one case, a 42 year old woman weighing 125 pounds fell 55 feet into packed garden earth, hitting at 54 feet/second (37 mph), with the earth indented 4 inches by her left side and back. The woman remained conscious and was uninjured, having experienced an average deceleration of 140 G, with an average loading of 13.3 pounds per square inch. Peak deceleration and pressure may have been considerably more than the "square wave" averages. Stapp also discusses an airman whose parachute did not open in a 1200 foot drop, with his striking the snow on his back at free fall terminal velocity (which would be attained after a fall of 482 feet) of 178 feet/second (120 mph), penetrating into the snow/ice layers 3.5 feet. With an average deceleration of 140.5 G, he sustained fractures of the second lumbar vertebra and clavicle, and a few bruises, but remained conscious.

We have summarized such data to say (16) that it is not acceleration that produces injury, but body distortion produced by the acceleration event. With proper support to minimize body distortion, acceleration tolerance is greatly increased. Best effects might be obtained by water immersion (16); airbag restraints with allowed motion in all directions appear to be the next best alternative.

When we performed the first test platform swing crashes with airbags in an airplane seat, it was the discomfort during rebound from the frontal airbag of "bottoming" on hard structures of the airplane seat back that led us to design the more yielding "airseat", which we feel should be in automobiles as well, since many injuries are produced by hard structures within seats, or by seat failures. Any surface that the body can hit should controllably deform at a load below that which can cause injury, over a distance long enough to safely dissipate the velocity of the body with respect to the surface.

More recently, we devised a new method to reduce rebound from airbag systems (17), which is conceptually similar to having a ratchet on a spring, which allows spring compression, but prevents spring expansion. This method consists of using one or more "flapper valves," sewn on three sides over wide vent holes connecting proximal and distal airbags. As the first (or proximal) airbag is compressed by body contact, the gases easily vent into the distal airbag (or several layers may be used). When the body displacement ceases, the now compressed gases are prevented by the flapper valves from returning rapidly to the proximal airbag, largely eliminating rebound. This effect has not yet been experimentally demonstrated. However, "flapper valves" have been used (18) on aspirator airbags to allow compartment air to enter the airbag while it is being expanded on filling, with the valves closing to reduce this extra venting during airbag compression.

This method of rebound reduction by multiple compartment layers and flapper valves rather than by venting prevents inflation gases from ejecting into the occupant compartment, so that other than totally benign inflation gases or reactions might be considered for use, although one needs to consider the possibility of bag rupture in some crashes.

An ideal airbag system for the elderly and the handicapped would easily open out for occupant entrance, including persons with casts or special braces, and would consist of multiple compartments which could be controlled in inflation to provide the support desired during normal (non-crash) transportation. The outer high pressure inflated structure is to provide reaction surface for the inner low pressure airbags in contact with the body. For those with body discomforts, selective inflation could support the body in ways, perhaps changing with time, to minimize discomfort. Indeed, a message function could be built into the proximal airbags, which include inflated structures supporting the body weight. With appropriate space in the vehicle, such as a van or ambulance, the support system could be selectively inflated to allow the handicapped person, for example, to sit up or lie down. To fill the selected airbag compartments, supply tanks filled with 80 psi filling station air, could perhaps be built into the wheel wells, for the more elaborate forms of such handicapped transport systems. For comfort, the airbags in contact above the body would be at perhaps two inches of water pressure, and those below the body at perhaps 5 inches of water pressure. This pressure is not uncomfortable, and indeed one can totally relax with such full body support (19).

In a crash, airbag compartments in any direction in which the body is being thrown would be inflated automatically, to a higher pressure if they are already inflated, or if space allows and the surrounding airbags are already inflated, the displacement of the body alone would pressurize the proximal airbag "below" the body (in the direction opposite to the vehicle acceleration). The use of multiple layers of airbag compartments has been experimentally developed only to the extent of my work, with co-workers, on the "airlitter" (19, 20), but offers the promise during impact of providing a smooth transition from very low pressure (5 inches of water) to very high pressure (20 psi if needed), with the bottoming load of each compartment layer being the load with which the next layer would begin to compress. The face, for example, hitting a 20 psi airbag, could be injured, but if it first pushes through airbags initially at lower pressure, the proximal airbags would distribute the load, reducing injury.

Figure 1 is a crude sketch of the kind of inflatable crash protection system for handicapped children with which we would like to experiment. It would be rather like the "Totguard" restraint, but with the outer shell an inflated 5 psi structure rather than rigid plastic. Before pressurization, the structure could unzip down the middle, to let the child with any cast or brace be positioned in the system, which would then be closed over him. For road travel, there would be an initial pressurization of the high pressure "shell," and lower pressure airbags to support the body. In a crash, additional airbags would be inflated to expand up and cover the chest and support the head. Airbags on the sides of the head could be partially inflated to support the head of the cerebral palsey child, for example, during normal driving. Ideally, a cooling system, perhaps using the Peltier effect to cool electrically, would be used to provide occupant comfort. The shell would be secured on the car seat with a lap belt and possibly a top tether.

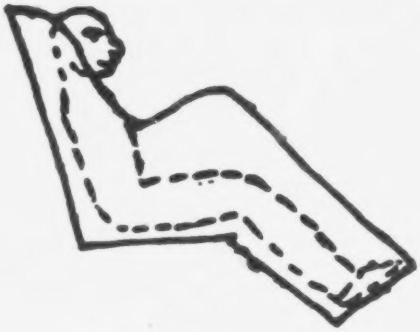


Figure 1: The handicapped child inflated protective system concept

Figure 2 is a crude sketch of a possible wheelchair occupant/driver restraint system. The forward outer shell, inflated to perhaps 10 psi, is like the toe of a slipper into which the wheelchair is pushed. The wheelchair frame would have flat surfaces front and back (not shown) against which additional 10 psi airbags would be inflated to support the wheelchair weight during impact. Within the slipper shell, limited distension airbags would fill the interstices, with the proximal airbags (touching the body) at low pressure until impact. Behind the slipper shell, airbags would be inflated on entry, at high pressure to support the wheelchair frame and at lower pressure to support the wheelchair back. A low pressure airbag would be between the wheelchair back and the occupant, to reduce rebound discomforts in a crash. On impact, airbags would inflate to support the chest and head, and perhaps shoulders laterally. This system has not yet been built.

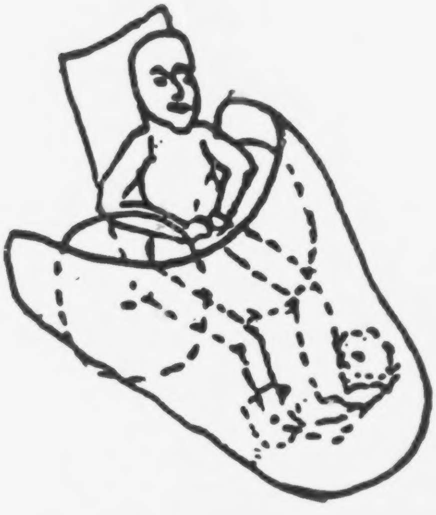


Figure 2: The wheelchair occupant protective system concept

A Special Case: Protection for the Hip and Head in A Fall

Finally, it is interesting to consider whether technology that has been developed for transportation safety, such as the airbag, might have a broader application. One such application could be the problem that afflicts so many elderly people, that of breaking the hip in a fall. Avioli reports (21) that some 200,000 people each year fall and break their hips, typically at the neck of the femur. Osteoporosis, the progressive demineralization of the bones of older people, and particularly of women, is often involved. Between 40,000 and 80,000 of these old people subsequently die due in significant part to the broken hip consequences. Baker, O'Neil and Karpf report (22) that 13,000 deaths per year of all ages are attributed on death certificates to falls, but note that the consequences of falls are significantly underreported as the cause of death. More than half of the deaths attributed to falls involve people 75 or older, who are about 4 percent of the population. Some 3.5 million person—hospital days are required annually to treat hip fractures of those 65 and older (23). This can be compared to the estimate of 4.2 million person—hospital days for the treatment of all ages for the consequences of all motor vehicle accidents.

Might airbag technology reduce these injuries and deaths? In discussing my concept of an airbag over the hip automatically triggered by the gravitational and angular motions of falling with Baker (24), she said that she too had wondered if a protective system could be effective for those at high risk. She warned that old people often "fall" into a chair; she had considered the use of pads not requiring an automatic inflation.

The standing height of the head of the femur is about half of the body height. Free fall from 2.5 feet under the 1 g of gravity involves contact in 390 milliseconds, with a velocity of 12.6 feet per second or 8.6 miles per hour. A femur head at 3 feet takes 430 milliseconds to impact at 9.4 mph. A fall while walking or getting out of bed is typically not a free fall; a partially supporting leg would lengthen the time to impact. We are aware that we are falling, and typically have time to put out an arm to catch ourselves, a process with a reaction time of a few hundred milliseconds. Airbag systems for automobiles have inflation times near 30 milliseconds—to get the airbag back to the person before significant forward motion on the seat has begun in the crash.

It would be possible to design sensors to trigger the inflation of a hip airbag through a combination of a detection of an acceleration of less than 0.5 G resultant at the waist of more than 100 milliseconds duration, and a body "roll" or lateral rotation with respect to a horizontal plane of more than 45 degrees. (For body motion terminology, still not standardized in spite of earlier efforts, see reference 25). Hip airbags on each side about a foot long and six inches deep when inflated, attached at the waist and about each leg, could soften the impact of the fall, (Figure 3).

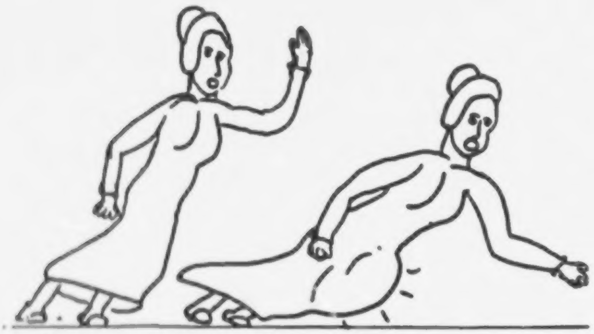


Figure 3: The hip airbag concept

The sensors could trigger the opening of a valve releasing compressed gas into a hip airbag. A small pressurized tank (perhaps as small as a seltzer bottle carbon dioxide cartridge) could provide a sufficient supply of gas. This tank would be connected to the valve prior to use, and easily replaced after use. The sensors, tank, and valve could be contained in a small unit worn on the waist. The valve would have a release control for deflating the airbags after inflation. Ideally, a hip airbag would be pressurized to such a level before impact that the impact load would be distributed over a much wider area than the femur, and would build up more slowly, to a lower force over a longer duration, perhaps with the femur barely "bottoming" through the airbag onto the floor, hopefully preventing the fracture.

Preliminary experimentation has been carried out at the Naval Air Development Center, under the direction of Marvin Shulman. A dummy was rolled off a 30 inch high table, to land on its hip, giving a 104 Gy load when unprotected and a 22 Gy load when protected by a four inch thick airbag inflated to human lung power inflation pressure. This level of protection is promising.

The device could be worn as an undergarment, ideally unnoticeable when uninflated, under loose clothing, to allow unrestricted inflation. To reduce rebound, a hip airbag could contain two compartments, an outer compartment of perhaps 4 inches connected to an inner compartment of 2 inches through a large diameter "flapper valve" which allows gas to move rapidly from the outer compartment to the inner compartment during compression by hip contact, but does not allow gas to return repidly to the outer compartment. Experimentation on the optimum configuration of the hip airbag obviously would be required. Whether the sensors should trigger the inflation of the hip airbag on just the exposed side, or on both sides, will depend on further study of the biomechanics of falls with hip fracture, and experimentation.

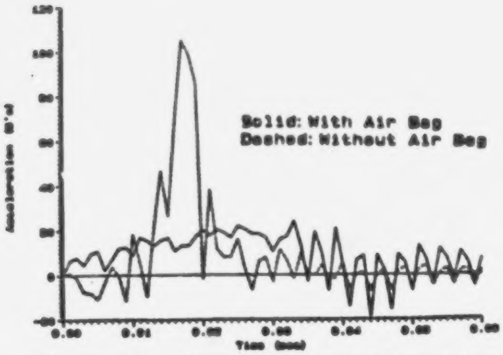


Figure 4: Dummy hip acceleration

Many of those injured in falls also strike their heads. For some years, we have been interested in making an elastic inflatable cap, like the old aviator's helmet, to replace the heavier helmets worn by cerebral palsy children, for example. Perhaps an inflatable cap can be part of this fall injury program, to be used by some preinflated (including bicyclists), and by others who wish to have their protection less noticable and so built into their hat design, with inflation during the fall.

The purpose of this entire discussion is to encourage the application of well understood technical principles to a wide variety of situations that currently produce harm. Injuries that could be avoided by the application of this knowledge should not be accepted. Nor should we restrict our horizons to motor vehicles transportation safety if what we know might be of help in related fields.

EDITORIAL NOTE

This is a condensed version of the Conference preprint paper, of 41 pages, which includes a more complete discussion with references of the work of others, including the early history of airbag restraint development. The preprint paper, document NRD-12-CC-84105, may be obtained from the author.

References

1. National Highway Traffic Safety Administration (NHTSA) Federal Motor Vehicle Safety Standards (FMVSS), the Advanced Notices of Proposed Rule Making (ANPRM) and the Notices of Proposed Rule

Making (NPRM), and the Final Rules (which are the mandatory standards or regulations) are published in the Federal Register (FR). The Federal Code version of the Federal Motor Vehicle Safety Standards is published annually in the Code of Federal Regulations (CFR), Title 49, Chapter V (Transportation), Part 571, with FMVSS 213, Child Restraint Systems, being designated in the Code as 49 CFR 571.213, for example. Both the Federal Register (published daily) and the Code of Federal Regulations (published annually) are available from the Superintendent of Documents, U.S. Government Printing Office (GPO), Washington, D.C. 20402. The NHTSA standards and other rules (Parts) are available in one volume, costing $13.00 (for the 1983 volume), containing Parts 400-999, of the many volumed CFR. The standards and Parts discussed in this report are Part 571, Federal Motor Vehicle Safety Standards FMVSS 201, Occupant protection in interior impact. FMVSS 208, Occupant crash protection. FMVSS 209, Seat belt assemblies.

FMVSS 210, Seat belt assembly anchorages. (Note that Section S4.1.1 requires that lap and shoulder belt anchorages be provided in all forward facing outboard seating positions, in passenger cars except convertibles—front or back. I encourage the public to ask the dealers for the locations of these rear seat shoulder belt anchorages, and install lap/shoulder belts in the outboard rear seats, for their greater protection than lap belts alone. This is particularly important for shoulder strap use by the 5 to 11 year old child using a booster seat for which the tether attachment for use of the child shoulder straps has not been made.). FMVSS 213, Child restraint systems. FMVSS 222, School bus passenger seating and crash protection. Part 572, Anthropomorphic Test Dummies. This gives the specifications for the fiftieth percentile male dummy, the three year old child dummy, and the 6 month old infant dummy. See Reference 3. Part 575, Consumer information regulations.

2. Rolf Eppinger, NHTSA, Prediction of thoracic injury using measurable experimental parameters. In the Report on the 6th International Technical Conference on Experimental Safety Vehicles, which was held in Washington, D.C., in October, 1976, Report DOT HS 802 501, NHTSA.

3. J. Robert Cromack and H. Haskel Ziperman, Southwest Research Institute, Three-point belt induced injuries: a comparison between laboratory surrogates and real world accident victims. Report SAE 751141, in Report P-62, the 19th Stapp Car Crash Conference, Society of Automotive Engineers (SAE), 400 Commonwealth Avenue, Warrendale, PA 15096, 1975.

4. L.M. Patrick and R.S. Levine, Wayne State University, Injury to unembalmed belted cadavers in simulated collisions. Report SAE 751144, in the 19th Stapp Car Crash Conference SAE, 1975.

5. Donald F. Huelke, Harold W. Sherman, and Audrey F. Elliott, University of Michigan Transportation Research Institute (UMTRI), Clinical case studies of lap-shoulder belt effectiveness in passenger car crashes. Report SAE 840197, in Report P-141, Advances in Belt Restraint Systems: Design, Performance and Usage, SAE, 1984.

6. Leda L. Ricci, Editor, UMTRI, National Crash Severity Study (NCSS) statistics: passenger cars. NHTSA Report DOT HS 805 531, Special report, June, 1980. Available as Document PB81-103400 from the National Technical Information Service (NTIS), Springfield, VA 22161.

7. Harold Roland and Brian Moriarity, System Safety Management and Engineering. John D. Wiley and Sons, New York, 1983.

8. National Highway Traffic Safety Administration, New Car Assessment Program (NCAP). For current and past data on the crashworthiness safety performance of motor vehicles, write or call the Office of Public and Consumer Affairs, NHTSA, Washington, D.C. 20590, phone 202-426-9550 or the NHTSA Hotline, 800-424-9393. See also James Hackney and Vincent Quarles, The New Car Assessment Program—Status and Effect. In the Ninth International Technical Conference on Experimental Safety Vehicles, Kyoto, Japan, November, 1982, Report DOT-HS 806 341, NHTSA, 1984. Available as Document PB84-207992, National Technical Information Service (NTIS), Springfield, VA 22161.

9. Education for all Handicapped Children Act of 1975, Public Law 94-142, as amended by P.L. 98-199, December, 1983.

10. Carl C. Clark et al., Martin Company, Technical proposal for a universal couch restraint system concept development, Engineering report 12434P, Martin Company, Baltimore, May, 1962.

11. Bruce Cooper, Carl Blechschmidt, Keith McCloskey, and Carl Clark, Martin Company, Human vibration and impact isolation with a full length airbag restraint system. Engineering Report R-146, Martin Company, Baltimore, March, 1963.

12. Carl Clark, Carl Blechschmidt, and Fay Gordon, Martin Company, Impact protection with the "airstop" restraint system. Proceedings of the Eighth Stapp Car Crash and Field Demonstration Conference, Wayne State University, October, 1964. Wayne State University Press, 1966.

13. Carl Clark and Carl Blechschmidt, Martin Company, Human transportation fatalities and protection against rear and side crash loads by the airstop restraint. Proceedings of the Ninth Stapp Car Crash Conference,

October 1965. Published by the University of Minnesota, 1966.

14. Hugh DeHaven, Mechnical analysis of survival in falls from heights of fifty to one hundred and fifty feet. War Medicine, Vol. 2, p. 586-596, July, 1942.

15. John Paul Stapp, The problem: biomechanics of injury. In The Prevention of Highway Injury; Proceedings of a Symposium, edited by Melvin Selzer, Paul Gikas, and Donald Huelke, published by the Highway Safety Research Institute, University of Michigan, Ann Arbor, 1967.

16. Carl Clark, The Martin Company, Acceleration and body distortion, Chapter 5 in Human Factors in Technology, edited by Edward Bennett, James Degan, and Joseph Spiegel, McGraw Hill Book Company, New York, 1963.

17. Carl C. Clark, NHTSA, Learning from child protection devices and concepts from outside the United States. Report SAE 831666, in the SAE Child Injury and Restraint Conference Proceedings, Report p-135, SAE, October, 1983.

18. Donald Friedman, President, Minicars, Inc., Development of advanced depolyable restraints and interiors. In Vehicle Safety Research Integration Symposium, p. 55—68, NHTSA, May, 1973.

19. Carl C. Clark, Library of Congress, Airbag restraints and airlitter systems for the alleviation of highway injury. In the Prevention of Highway Injury, Proceedings of a Symposium, edited by Melvin Selzer, Paul Gikas, and Donald Huelke, published by the Highway Safety Research Institute, University of Michigan, Ann Arbor, 1967.

20. Carl Blechschmidt and Carl Clark, An inflated "airlitter" for transportation and impact protection of the injured. Engineering Report 14109, Martin Company, Baltimore, January, 1966.

21. Louis V. Avioli, Osteoporotic Syndrome, Detection, Prevention, and Treatment, 1983. Grune and Stratton / Academic Press, Orlando, FL 32887.

22. Susan P. Baker, Brian O'Neill, and Ronald S. Karpf, The Injury Fact Book. An Insurance Institute for Highway Safety Book. Lexington Books, D.C. Heath and Company, Lexington, Massachusetts, 1984.

23. B.J. Haupt and E. Graves, Detailed diagnosis and surgical procedures for patients discharged from short-stay hospitals: United States, 1979. Publication (PHS) 82-1274-1, U.S. Department of Health and Human Services, Washington, D.C., 1982.

24. Susan P. Baker, School of Public Health and Hygiene, Johns Hopkins University, personal communications, August, 1984.

25. Carl C. Clark, James D. Hardy, and Richard J. Crosbie, Naval Air Development Center, A proposed physiological acceleration terminology, with an historical review. In Human Acceleration Studies, Publication 913, p. 7—65, National Academy of Science, Washington, D.C., 1961.

Carl C. Clark, is in the Crashworthiness Research Division of the Office of Vehicle Research, National Highway Traffic Safety Administration, United States Department of Transportation, Washington D.C. 20590.

IMPROVING THE PERFORMANCE OF TRANSPORTATION TO THE HANDICAPPED THROUGH USER-SIDE SUBSIDIES: CALGARY'S EXPERIENCE

David Colquhoun and Dan Bolger

Introduction

Two trends have recently dominated the development of specialized door to door services for the elderly and handicapped in Canada. The first is the decision of municipalities to opt for contractual arrangements with private transit management companies and non-profit agencies rather than providing service as part of the regular transit system. A second trend is the predominance of vehicle systems dedicated solely to the provision of elderly and handicapped service.

The City of Calgary has been active for many years in the development of specialized transit services for the handicapped. In the early 1970's, Calgary became one of the first Canadian cities to introduce a door to door Handibus service for persons unable to use regular public transit. In the intervening period Calgary has expanded the scope of its special services in a manner somewhat unique for Canada through the development of taxi-based systems for the ambulatory handicapped and the organization of service along user-side subsidy principles. This method of subsidization differs form the more traditional transit subsidies in that the users rather than the providers of transportation are subsidized. Persons eligible for the subsidy pay only a portion of the full fare for the trips taken via the selected transportation provider. The service operator is then reimbursed for the remainder of the fare by the subsidizing agency.

This paper will draw upon performance reviews and user surveys undertaken in Calgary to outline how the special Handibus and subsidized taxi programs have been developed and subsequently modified in an attempt to improve the overall cost efficiency and effectiveness of the service delivery. Emphasis will be placed on the applicability of taxi based services and user-side subsidy principles to elderly and handicapped transportation, drawing upon historical data and recent experiments which integrated taxi and special van services. The paper concludes with a review of the applicability of Calgary's experience to other jurisdictions.

Calgary Context

Calgary is situated in the foothills of the Rocky Mountains in Western Canada and is the "capital city" for Canada's petroleum industry as well as a major agricultural centre. In 1983, the City population was approximately 623,000 encompassed in an area of approximately 510 sq. km.

On the basis of information obtained from recent interview surveys of disabled organizations and institutions, it is estimated that there are a minimum of 17,500 mobility limited disabled persons residing in Calgary of which 14,300 persons (2.3 percent of the population) are unable to use regular public transportation, and 3,200 persons (0.5 percent of the population) able to use it but with much difficulty. Although the estimate of 17,500 mobility limited disabled persons represents a measure of the market for specialized transit services, it has been demonstrated that the mobility requirements of disabled persons vary significantly depending upon the nature of their functional limitation. For example, in Calgary it is estimated, based on agency surveys that only one quarter of the mobility limited disabled (3,600 persons) are wheelchairbound and require specially modified vehicles and special assistance in travelling within the City. The remainder of this group (approximately 10,600 persons) are ambulatory and are physically able to be transported in a regular automobile such as a taxi.

Travel behavior data obtained from surveys of disabled populations in Calgary indicate that although a large number of private and public agencies are participating in the delivery of transportation service, the city-funded handibus and subsidized taxi services are clearly the dominant modes of travel used by the transportation handicapped. Present trends indicate that Calgary's disabled population makes about 50 percent less non-work trips and 85 percent less work trips than the general population.

Population projections for Calgary to the year 2000 indicate that population of the elderly (65 years and over) age group will more than double. Since the incidence of disability has been found to increase with age, it is expected that there will be continued strong demand for specialized Handibus and taxi services. These facts also suggest that it will become increasingly important to maximize cost-effectiveness in the delivery of transportation services to this segment of the population.

EXHIBITS 1, 2, & 3

EXHIBIT 1

HANDIBUS AND SUBSIDIZED TAXI SERVICE ANNUAL BUDGET, 1975 - 1983

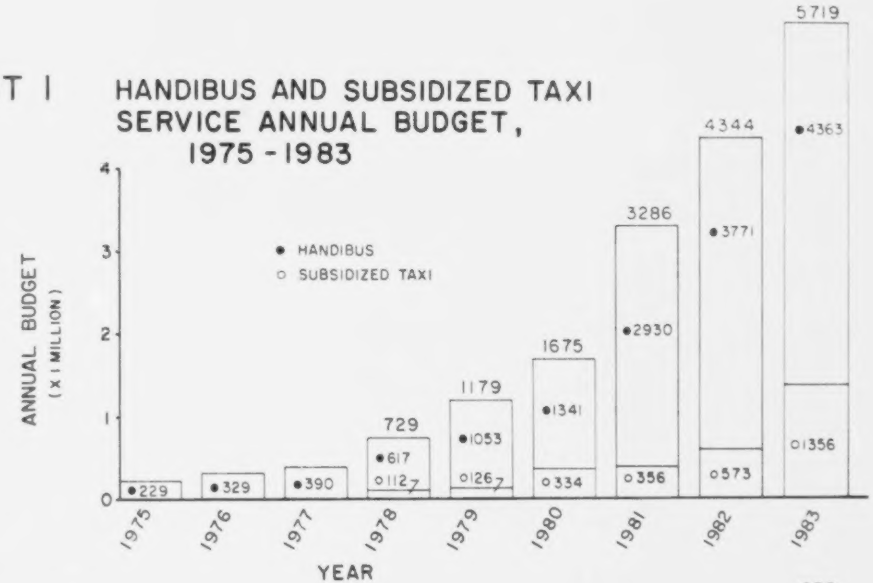


EXHIBIT 2

HANDIBUS AND SUBSIDIZED TAXI SERVICE PATRONAGE DATA 1975 - 1983

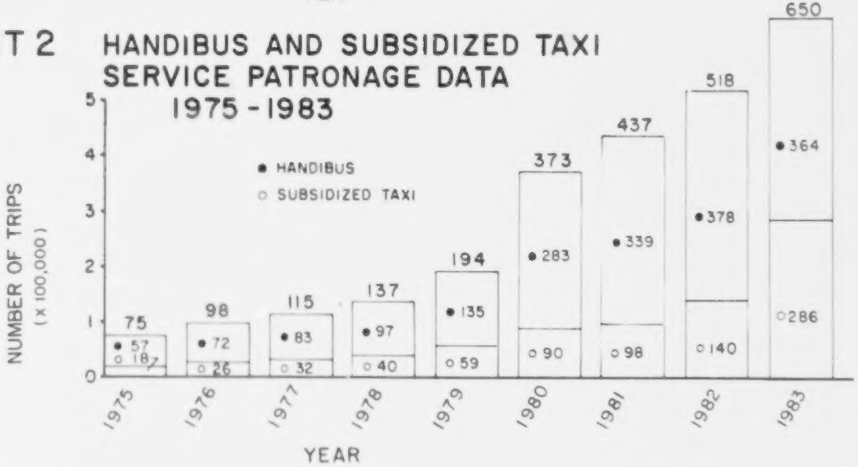
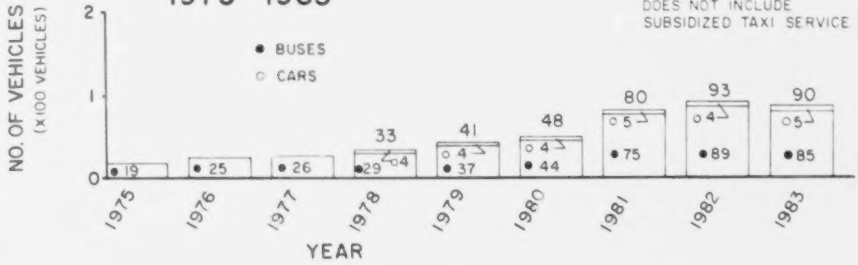


EXHIBIT 3

HANDIBUS FLEET SIZE 1975 - 1983



Handibus And Subsidized Taxi Program Desciption

Calgary's Handibus and subsidized taxi programs have historically performed unique roles in accommodating the urban travel requirements of the City's elderly and handicapped population. A brief summary of the background and characteristics of these services is useful as an aid to understanding the rationale for recent service modifications.

Handibus—The city-funded Handibus service provides dedicated subscription, charter and demand responsive service to disabled Calgarians who are unable to use regular public transportation with dignity or without assistance. The program is administered and operated by Calgary Handibus Association, which is an independent, non-profit organization registered under the Alberta Societies Act.

The recent development of the Handibus service has been significantly influenced by controversy and debate on the relative merits of rail transit (LRT) accessibility versus specialized parallel transportation. Although Calgary City Council decided in 1979 that it would be inappropriate to make the initial leg of LRT fully accessible to the handicapped, the ensuing debate did lead to the adoption of a policy objective that service on Handibus be offered in a one hour response time, seven days a week, 6:00 a.m. to 1:30 a.m. This decision has resulted in a dramatic increase in service patronage and the level of operating subsidies provided by the City of Calgary (see Exhibits 1 and 2).

Expansion has also been aided by donations of buses and major equipment items by various clubs, organizations and individuals (see Exhibit 3).

Until recently, eligibility criteria for Handibus were defined according to age and type of disability. Service was available to the wheelchairbound regardless of age and to the ambulatory disabled under age 65. Persons reaching age 65 who were not confined to a wheelchair were transferred to the subsidized taxi program.

Subsidized Taxi—The city subsidized taxi program employs a user-side subsidy concept which allows handicapped users to purchase trips from commercial taxi operators at fares well below those charged to the general public. This service was initiated in 1974 and is presently operated by eight taxi companies under contract to the Handibus Association. Historical data on the annual budget and ridership is summarized in Exhibits 1 and 2.

Prior to the institution of recent service charges, the subsidized taxi service was available to the ambulatory disabled over age 65, upon submission of medical certification confirming the applicant was physically unable to use regular transit with dignity or without assistance. The program provided for a maximum monthly subsidy of $45.00 in taxi fares. This allowance covered the sum of all taxi meter charges less a 10 percent discount per trip (borne by the taxi operator) less the one way trip fare of $1.50.

Handibus and Subsidized Taxi Operational Review

In early 1981, the City of Calgary Transportation Department initiated an operational review of the Handibus and subsidized taxi programs in conjunction with a broader study to assess the transportation needs of the elderly and handicapped in Calgary.

The objectives of the Handibus and subsidized taxi review were two-fold:

(a) to evaluate how well actual service provided accommodates existing and projected travel demand.

(b) to assess the need for policy and procedural changes to improve service efficiency and affectiveness.

Operating and financial data were utilized as criteria for assessing system efficiency and effectiveness In addition, the input of user groups and other spokespersons for the disabled community was actively sought through a major questionnaire survey of 12,000 disabled persons and interviews with approximately 40 agencies serving the elderly and handicapped in Calgary. The following points summarize the major findings of this review.

Service Effectiveness

It was determined that Handibus was providing a high level of service to program users and achieving the city approved objective for 1 hour demand-reponse service. On-demand service comprised approximately 62 percent of all weekday trips compared with approximately 34 percent subscription travel and 4 percent for charter service. Service refusals averaged only 1 percent of total daily ridership on a typical weekday and 5 percent on weekends

Overall utilization routes for both the Handibus and subsidized taxi programs were observed to be quite low despite an average monthly increase in registration of 100 and 200 persons respectively. Fewer than 50 percent of registered users typically made use of the services in any given month. The average number of one-way trips per person was approximately 4 per month for the subsidized taxi service and 10 per month for Handibus

Input received through the questionnaire and personal interview surveys confirmed that there was a significant level of user satisfaction with both programs. Sixty-eight percent of questionnaire respondents rated Handibus service as commendable or satisfactory while 83 percent gave a similar rating to subsidized taxi.

Service Efficiency

Based on the cost and performance trend data in Tables 1 and 2, it is apparent that the Handibus service has main-

TABLE 1

Calgary Handibus Service
Cost/Productivity Summary, 1978—1982

	1978	*1979*	*1980*	*1981*	*1982*
Operating Costs	$ 80,798	$1,358,091	$1,803,946	$2,929,529	$3,771,376
Number of Km operated	1,655,857	2,239,171	2,510,375	3,332,825	3,852,569
Number of trips/day	536	702	774	930	1,174
Number of trips/vehicle hour	N/A	N/A	N/A	1.6	1.9
Cost/trip	$4.50	$5.30	$6.67	$8.63	$9.98
Subsidy/trip	$3.75	$4.55	$5.92	$7.88	$9.08
Cancellation Rate	32%	1-2%	1-2%	1-2%	1-2%
Fare	75¢	75¢	75¢	75¢	75¢
% Operating Cost recovery from fare box	16%	15%	10%	7%	9%
Fleet size	37	48	51	80	93

TABLE 2

Subsidized Taxi Service
Cost/Patronage Summary, 1978—1982

	1978	*1979*	*1980*	*1981*	*1982*
Operating Cost	$99,148	$164,342	$306,709	$355,539	$572,999
Number of Trips	39,898	58,708	90,301	98,020	140,264
Average Cost/Trip	$3.99	$4.30	$4.90	$ 5.12	$5.59
Subsidy/Trip	$2.49	$2.80	$3.40	$3.62	$4.09
Average Number of Trips/Person Monthly	4	4	3.9	3.7	4

tained low levels of productivity as reflected by the number of one-way trips accommodated per vehicle hour. Considerations which contribute to the relatively low vehicle load factors include:

(1) long average trip lengths (10.1 km) and heavy levels of congestion on major roadway arterials during peak travel periods,

(2) the relatively high proportion of "unpredictable" on-demand trips (63 percent),

(3) the highly personalized nature of the service, often requiring provision of assistance from the driver to buildings at the trip origin and destination.

The average cost per trip for the subsidized taxi program has remained below that recorded by Handibus. The lower cost of the taxi service is attributable to:

(i) shorter distances for taxi trips compared with handibus. This possibly reflects a user awareness of the subsidy limit provisions of this program.

(ii) higher user fares for subsidized taxi travel ($1.50/trip compared with $0.90 for Handibus).

(iii) inherent efficiencies in user-side subsidy principles. One of the main advantages of this approach over dedicated, fixed capacity systems such as Handibus is that the funding agency pays only for the quantity of service consumed This protects the funding agency from having to pay for unused service or capacity during periods of low travel demand.

Identification of Improvement Options

The results of the user surveys and the operational review demonstrated that latent demand for the Handibus and subsidized taxi services was relatively low. Despite these findings, an evaluation was undertaken to assess the cost-effectiveness of service delivery in light of anticipated travel demand by the disabled. It was concluded that although it would be feasible to continue expanding the Handibus service to accommodate both the ambulatory and non-ambulatory segments of the market, a more cost-effective approach would be to transfer ambulatory Handibus users to a subsidized, taxi based service.

Issues

Potential issues anticipated with the above proposal were the more restrictive travel limitations and higher user fares associated with the taxi program, as well as the need to accommodate group trips involving wheelchairbound and ambulatory users, originating from nursing homes and auxiliary hospitals. To address these concerns, new provisions were incorporated to make the two programs more compatible.

The decision was made to transfer only the on-demand service for the ambulatory disabled to the taxi industry, thus retaining regular subscription service as a responsibility of Handibus. This would allow the operator to continue to assign subscription trips as routes to Handibus vehicles, thereby maintaining reasonable vehicle load factors and making maximum use of available service capacity

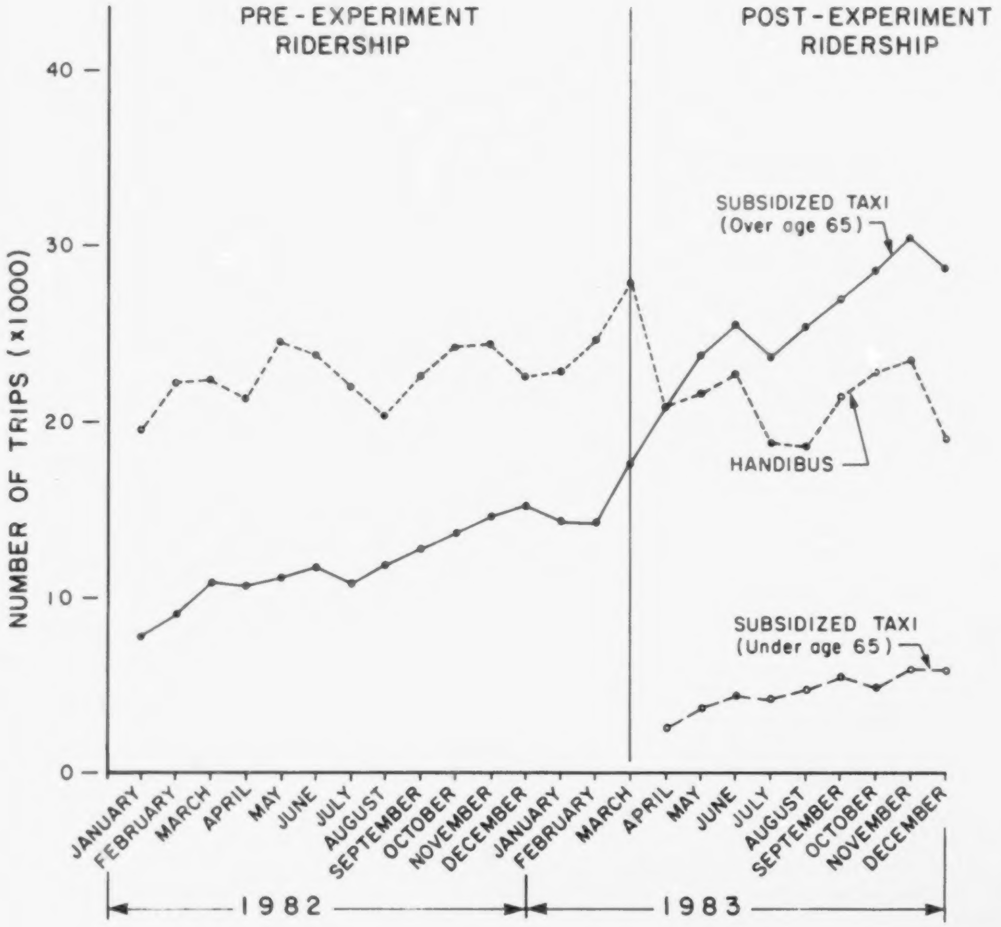
Handibus would continue to provide transportation for group trips originating from nursing homes and auxiliary hospitals.

User fares for the handibus and subsidized taxi services were established at a similar level for a six month trial period. This had the effect of reducing the user fare for the subsidized taxi service from $1.50 to $0.90 per one-way trip.

The monthly subsidy level for the taxi program was increased from $45.00 to $70.00, also on a six month trial basis. This level was calculated to allow the potential for approximately ten one-way trips of a 10 km distance,

EXHIBIT 4

HANDIBUS AND SUBSIDIZED TAXI RIDERSHIP BEFORE AND AFTER EXPERIMENT



which was equivalent to the average trip length and number of monthly trips taken by handibus users.

Anticipated Benefits

The increased emphasis on taxi-based elderly and handicapped service was expected to offer the following benefits:

— reduce the rate of growth in demand and operating costs for the handibus service by maximizing the use of lower cost, taxi based services.

— improve travel opportunities for existing and new subsidized taxi users through increased subsidy limits and a greater selection of service providers from which to choose.

— improve service for wheelchair users of handibus. This segment of the population has a greater need of the special vehicles and custom services provided by the Handibuses Association than the ambulatory disabled who, in most cases, could be transported in a regular automobile with limited assistance.

Experiment Results

This section examines the effect of the transfer of ambulatory handibus users and the institution of revised taxi fare and subsidy limit provisions on program ridership, user satisfaction and costs.

Ridership—As expected, the changes in structure of the handibus and subsidized taxi program improved travel opportunity which resulted in increased usage by patrons of both services. In the handibus service, there was a decrease in the number of users per month due to the transfer of ambulatory users to the subsidized taxi service but an increase in the number of average monthly trips per user from approximately 10 to 18. As noted in Exhibit 4, there was no significant change in total monthly trips delivered by the program.

In the subsidized taxi program, the most dramatic increase in ridership was observed among the elderly (over 65) age group who previously used the program. Average monthly usage increased only slightly from approximately 4 trips per user to approximately 5.5 trips per user. The rate of new registration however, increased dramatically from an average of 200 users per month to 300 users per month. The result was a rapid increase in total trips delivered under this component of the program (see Exhibit 4). By contrast, the growth in the under 65 age component of the program was more moderate, despite a higher usage rate of 8.5 trips per user per month.

User Satisfaction—User surveys conducted after the introduction of the new taxi fare and subsidy structure indicated a very favourable attitude toward the program among the elderly age group, no doubt resulting from the more generous program provisions. In the under-65 age group, it is significant that the majority of users found the taxi program to be generally more satisfactory and responsive to their travel needs than handibus, perhaps due to improved availability of transportation and the variety of transportation providers involved in this program.

Costs—As a result of the lower taxi fares and higher subsidy limits, the average cost of the subsidized taxi service increased during the term of the experiment from $4.02 to $4.74 per trip. When compared against the average trip cost of $12.25 for Handibus, it is evident that there were economic advantages to transferring on-demand service for ambulatory Handibus users to the subsidized taxi program. These benefits however, were overshadowed by the rapid growth in ridership and costs in the elderly component of the taxi program which occured after the fare and subsidy modifications. The total program cost increased from the pre-experiment level of $573,000 in 1982 to $1.6 million in 1983. A further escalation to $2.5 million in 1984 was projected if current usage trends continued. When faced with this situation and the risk of continued cost increases on the same magnitude, City Council directed that the following steps be taken to curtail service growth:

(a) introduction of more specific medical eligibility criteria.

(b) introduction of a sliding subsidy limit based on income.

(c) reinstitution of $1.50 taxi fare.

(d) introduction of annual renewal of user identification cards.

(e) limits on the number of taxi cards to one per family.

These program modifications are expected to reduce total program costs from $2.5 million to $2.1 million in 1984.

Conclusion/Transferable Lessons

On balance, the City of Calgary's experience has demonstrated that taxi based systems employing user-side subsidies can provide a very attractive method of delivering effective, low cost transportation to the elderly and handicapped market. The significant conclusions from Calgary's experience with this type of program are summarized below:

The cost to the public to subsidize a taxi trip using a user-side subsidy program is substantially less than the average per trip cost of dedicated fixed capacity systems such as Handibus.

The high cost of specialized taxi and Handibus operations relative to regular mass transit suggests that attention should be paid to carefully defining program eligibility in order that financial resources be directed to persons most likely to need special transportation. Many handicapped and elderly individuals may not necessarily need special transportation services because they are automobile drivers, have someone to drive them or are able to use regular fixed route transit.

Taxi-based transportation appears to have the greatest applicability to the ambulatory segment of the handicapped market, typically comprised of persons with relatively minor mobility limitations. The use of commercial taxi carriers to accommodate these persons allows Handibus operators to direct their service to the non-ambulant, wheelchair market who have a greater need for specialized vehicles and assistance.

Taxi services have been well received by elderly and handicapped target groups. The taxi industry in Calgary has also been very supportive of the program and are willing to absorb small subsidy and administrative costs in return for the expectation of increased business. It should be noted, however, that support extends primarily to the ambulatory and elderly segment of the handicapped market. Although most taxi companies will accept trip bookings from the wheelchairbound, a majority have indicated that they are not keen to encourage a greater level of patronage for this segment of the population.

There is no evidence to suggest that the quality of service provided by taxi operators is any different from subsidized or non-subsidized users. On the contrary, taxi operators have demonstrated a willingness to provide special attention at no additional charge to the user.

In conclusion, Calgary's experience demonstrates that taxi-based user-side subsidy programs have a potentially valuable role to play in handicapped transportaton either as a complement to dedicated paratransit operations or as a separate, freestanding program. Two of the inherent advantages of the concept are its flexibility and cost efficiency, factors which allow it to be applied to urban centres with widely different population characteristics and financial resources.

David Colquhoun is a Transportation Planner, and Dan Bolger is the Manager of Transportation Planning, for the City of Calgary, Calgary, Alberta, Canada 2TP 2M5.

COST-EFFECTIVE DATA COLLECTION PROCESS TO SUPPORT TRANSPORTATION PLANNING FOR TRANSPORTATION-HANDICAPPED PEOPLE

Daniel L. Dornan, David P. Middendorf, Richard P. Steinmann

Introduction

This paper briefly describes a data collection process for use by local transportation planning agencies and transit operators in planning, designing, and evaluating public transportation services and facilities for use by transportation-handicapped people. It is based on an extensive five-year research effort, conducted by a national consulting firm for the Urban Mass Transportation Administration, which assessed various methods of collecting data concerning the composition and transportation needs of transportation-handicapped people. The resulting process consists of several data collection techniques which together address the following issues:

- What is the size of the transportation-handicapped population within a local area?
- What are the characteristics of the local transportation-handicapped population in terms of disability, geographic distribution, and transportation needs?
- What are the travel habits of the local transportation-handicapped population?
- How effective are current public transportation services and facilities in serving transportation-handicapped people's needs?

Background

In 1970 Congress amended the Urban Mass Transportation Act of 1964 to declare as a national policy that "elderly and handicapped persons have the same right as other persons to utilize mass transportation facilities and services." Congress also authorized the Secretary of Transportation to require that special efforts be exerted in the planning of mass transportation facilities and services to ensure that they could be used effectively by elderly and handicapped persons.

The "special efforts" requirement was eventually incorporated into the urban transportation planning process in September 1975 when the Urban Mass Transportation Administration (UMTA) and the Federal Highway Administration (FHWA) jointly issued regulations requiring that special efforts be made to make mass transportation facilities and services useful to elderly and handicapped persons. These regulations also made federal funding of local transit operating and capital programs contingent upon compliance with the "special efforts" requirement. These regulations were subsequently expanded and clarified in April 1976 when UMTA and FHWA issued guidelines advising transportation planners to rely on existing sources of data as much as possible to obtain information on the location and transportation needs of elderly and handicapped persons, particularly wheelchair users and semi-ambulatory handicapped persons. UMTA and FHWA also suggested that planners use self-identification techniques rather than elaborate survey methods to locate transportation-handicapped persons.

Initial attempts by state and local planning agencies to obtain usable data on the location and transportation needs of elderly and handicapped persons from existing sources and self-identification techniques were not very successful. Although there were many secondary sources of information about the nature and travel characteristics of elderly and handicapped people, each source had numerous limitations. No single existing source or combination of sources provided complete, accurate, and reliable information on elderly and handicapped people living in urbanized areas. In addition, self-identification survey techniques proved inadequate either for developing representative samples of elderly and handicapped people or for locating a large sample quickly.

The limitations of these data collection techniques prompted UMTA to study alternative methods of collecting information on the transportation-handicapped portion of the elderly and handicapped population. UMTA considered various methods, including:

- primary data collection;
- use of secondary data sources; and
- use of self-identification survey techniques.

Exhibit 1 summarizes the major techniques associated with each of these data collection methods, while Exhibit 2 compares the three methods relative to several evaluation criteria.

After reviewing and testing various data collection methods in a series of demonstration projects, UMTA selected several techniques which together provide a com-

EXHIBIT 1

DATA COLLECTION METHODS FOR TRANSPORTATION-HANDICAPPED PLANNING

PRIMARY DATA COLLECTION

- Home Interviews
- Telephone Interviews
- Mail Surveys
- Trip Diary
- Field Observations
- On-Board Surveys
- Passenger Counts
- Focus Panels
- Product Testing Techniques

SELF-IDENTIFICATION SURVEY TECHNIQUES

- Self-Administered Mailback Questionnaires
- Self-Initiated Telephone Responses
- Personal Interview at Designated Location
- Registration for Special Programs

SECONDARY DATA SOURCES

- Census of Population and Housing
- Health Interview Survey
- Social Service Agencies
- Private Service or Membership Organizations
- Local Transportation Studies
- Registration Files
- UMTA National Survey of Transportation Handicapped People

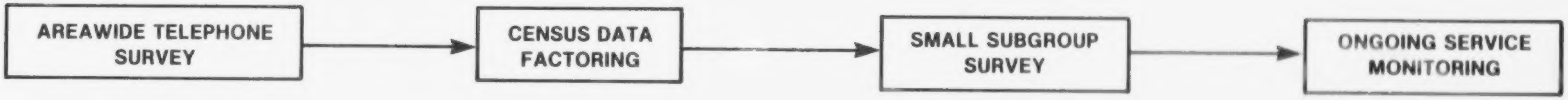
EXHIBIT 2

COMPARISON OF DATA COLLECTION METHODS FOR TRANSPORTATION-HANDICAPPED PLANNING

EVALUATION CRITERIA	PRIMARY DATA COLLECTION	SELF-IDENTIFICATION SURVEY TECHNIQUES	SECONDARY DATA SOURCES
Amount and Variety of Data	Extensive	Limited	Variable
Accuracy	High	Low	Variable
Representativeness	High	Low	Variable
Coverage	High	Low	Variable
Response Rate	Moderate	Low	Not Applicable
Time Required	Moderate	High	Low
Cost	Moderate to High	Low	Low
Potential Restrictions	Few	Many	Variable
Currentness	High	High	Variable

EXHIBIT 3

DATA COLLECTION PROCESS FOR TRANSPORTATION-HANDICAPPED PLANNING



AREAWIDE TELEPHONE SURVEY

- Screening Questionnaire Identifies Areawide Transportation-Handicapped Sample
- Handicapped Person Questionnaire Provides Socio-Economic and Travel Characteristics of Areawide Transportation-Handicapped Sample

CENSUS DATA FACTORING

- Distribute Areawide Transportation-Handicapped Sample Data to Subarea Level

SMALL SUBGROUP SURVEY

- Augments Areawide Telephone Survey Data with Information on Small Subgroups of Transportation-Handicapped Population Which Might Otherwise be Underrepresented

ONGOING SERVICE MONITORING

- Registration Files, On-Board Counts, and Service Inquiry Files Used to Monitor and Evaluate Public Transportation Use by Transportation-Handicapped People prehensive data collection process for use in local planning for the transportation needs of transportation-handicapped people.

Elements of the Data Collection Process

The data collection process for developing information on the transportation-handicapped population of a local area consists of three interrelated elements, each of which represents a separate technique or group of techniques, and a fourth element for continued service monitoring. Multiple techniques are used because no one technique can effectively and efficiently provide all the information needed for properly planning for the needs of transportation-handicapped people.

The first three elements of the data collection process provide increasingly detailed information regarding the number, characteristics, and needs of the local transportation-handicapped population. This information is used primarily for developing new services or service change. These three interrelated elements are:

- *Areawide Telephone Survey*—to establish the overall size, characteristics, travel habits, and transportation needs of the local transportation-handicapped population.
- *Census Data Factoring of Areawide Telephone Survey Data*—to estimate the geographic distribution of the local transportation-handicapped population by census tract or other small subarea.
- *Small Subgroup Survey*—to develop, with the help of local social service organizations, additional documentation on small but important subgroups of the transportation-handicapped population.

The fourth element extends the data collection process beyond the planning and design stages to the monitoring and evaluation stages. This fourth element is:

- *Ongoing Service Montoring*—to monitor and evaluate the use of public transportation services by transportation-handicapped people through registration files, on-board counts, and/or service request and inquiry files.

Exhibit 3 illustrates the four-part data collection process described above.

Areawide Telephone Survey

The first step in the recommended data collection process is the areawide telephone survey. The purpose of the survey is to locate transportaton-handicapped people and obtain information concerning:

- their disabilities;
- the nature of their travel habits; and
- their transportation problems and needs.

The areawide telephone survey technique involves contacting by telephone individuals who live in the study area. It requires the use of two questionnaires. The first questionnaire, called the screening questionnaire, enables the interviewer to screen a random sample of households in the study area to identify those with transportation-handicapped residents. The second questionnaire, called the handicapped person questionnaire, is completed only for persons identified in the study sample as transportation-handicapped. This second questionnaire is more detailed than the screening questionnaire since it includes numerous questions regarding the transportation problems, needs, and actual travel habits of the persons interviewed.

The areawide telephone survey requires a relatively small random sample of residences to be contacted to produce reliable information concerning transportation-handicapped people on an areawide basis (e.g., city, transit district, or Standard Metropolitan Statistical Area). For most local areas, a sample size of two to three thousand households should be adequate for estimating the size of the local transportation-handicapped population. A much larger sample would be needed to produce equally reliable information on a disaggregate, subarea basis (e.g., neighborhood, census tract, or travel analysis zone). Exhibits 4 and 5 illustrate the approximate sample size and cost for an areawide telephone survey which estimates the number and trip rate of transportation-handicapped people in urban areas of various sizes. The costs are based on successful pilot areawide telephone survey conducted in Dayton, Ohio, in 1980.

Census Data Factoring of Areawide Telephone Survey Data

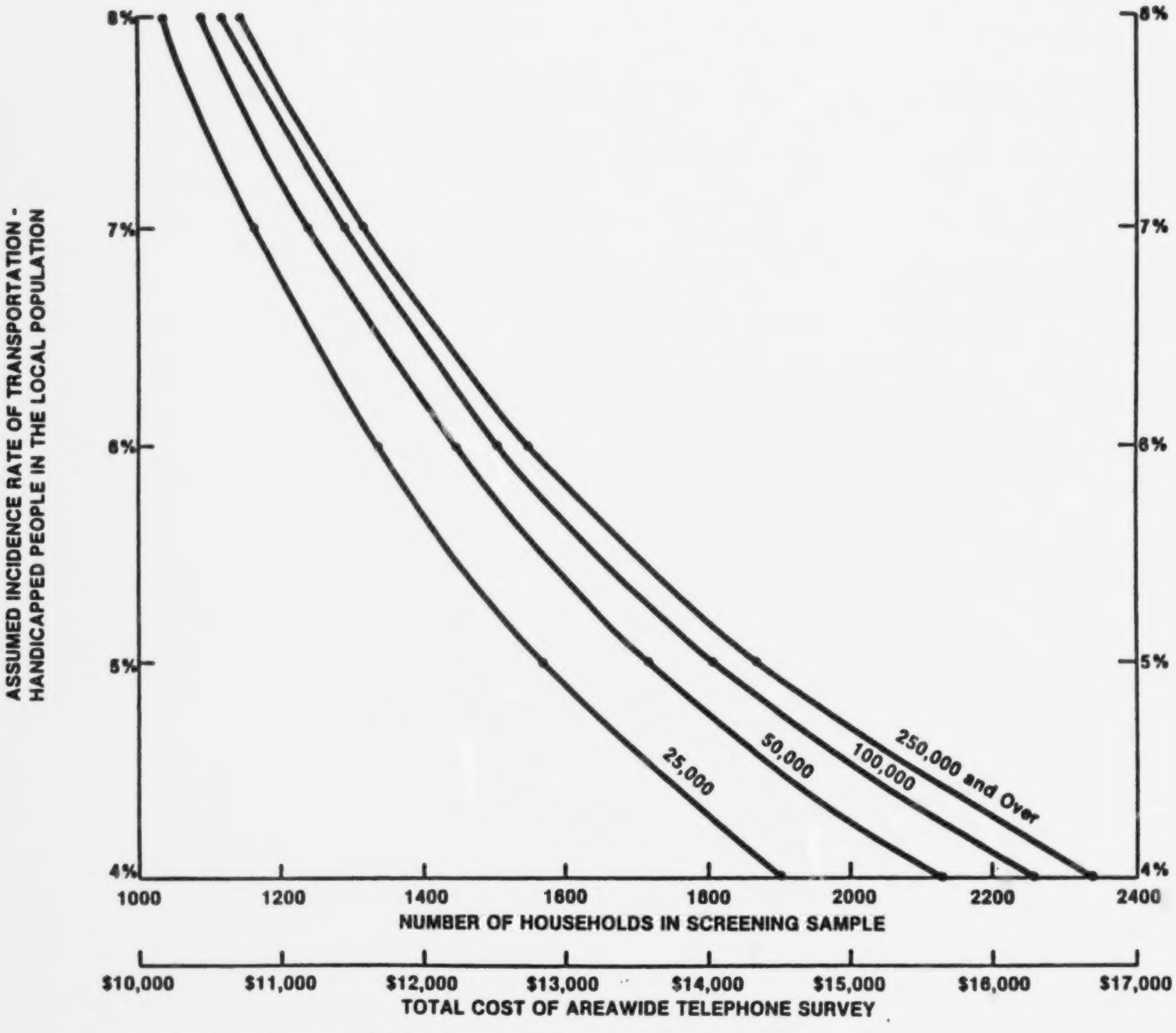
Research has demonstrated that transportation-handicapped people are not uniformly distributed over an entire urban area. Therefore, some method is required to break down the areawide information on transportation-handicapped people to the subarea level of detail.

Instead of greatly expanding the size of the sample included in the areawide telephone survey, data from the 1980 Census can be used to disaggregate areawide information to the census tract level. This capability is unique to the 1980 Census, which included a question pertaining to a person's ability to use public transportation due to a physical or mental handicap.

This second element of the process consists of developing the percentage of transportation-handicapped people for each census tract in a specified study area. This is done using the 1980 Census and applying the resulting percentages to areawide data developed from the areawide telephone survey. This is a very cost-effective technique since it provides a single yet reliable method

EXHIBIT 4

SAMPLE SIZES AND COSTS FOR ESTIMATING THE NUMBER OF TRANSPORTATION-HANDICAPPED PEOPLE IN URBAN AREAS OF VARIOUS SIZES[1,2]

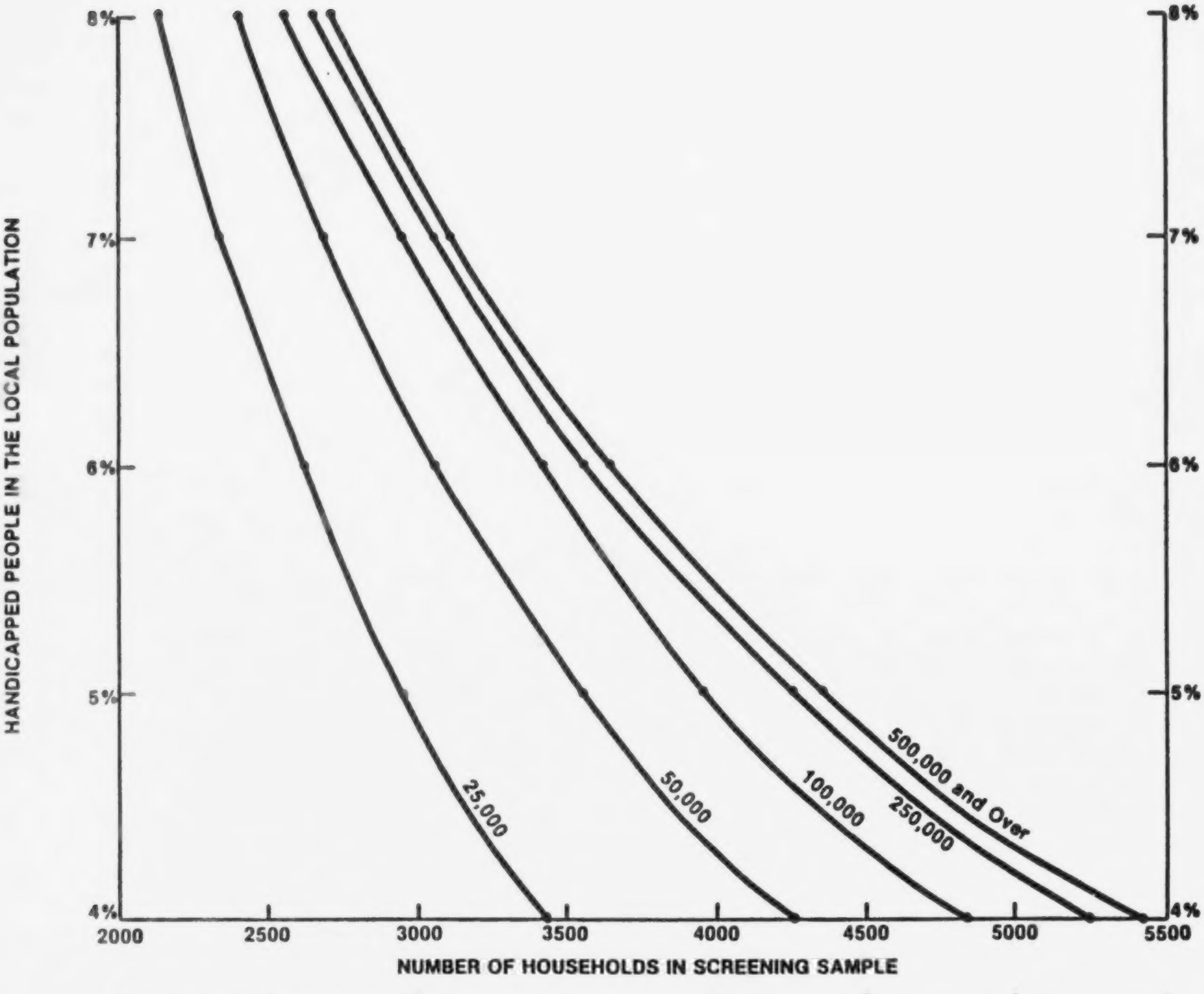


[1] Assuming a 90% Level of Confidence and 10% Relative Error.

[2] Population of Urban Area Indicated on Each Line.

EXHIBIT 5

SAMPLE SIZES AND COSTS FOR ESTIMATING THE TRIP RATE OF TRANSPORTATION-HANDICAPPED PEOPLE IN URBAN AREAS OF VARIOUS SIZES[1,2]



[1] Assuming a 90% Level of Confidence and 10% Relative Error.

[2] Population of Urban Area Indicated on Each Line.

213

of disaggregating the areawide telephone survey data without increasing the size of the telephone survey sample. For most urban areas, developing and applying census tract percentages of transportation-handicapped people will require only a couple days of staff time, plus the cost of acquiring one or two reels or printed tabulations of census data.

Small Subgroup Survey

The incidence rate of certain subgroups of the transportation-handicapped population, such as wheelchair users, blind people, and mentally disabled people, is usually so small that an areawide telephone survey will not locate enough of them to yield statistically significant information. Therefore, another technique must be used to identify a large enough number of such people to provide meaningful results. This technique, the third step in the recommended data collection process, entails collecting information on such subgroups through the assistance of social service organizations.

This technique is not intended to develop a probability sample of certain transportation-handicapped subgroups, since the sampling technique is neither random nor necessarily representative. It excludes persons within each subgroup who are not clients of the social service agencies or other local organizations. However, the technique can quickly locate a significant number of individuals from small subgroups of the transportation-handicapped population whose views might not otherwise be adequately reflected by the areawide telephone survey results.

The cost of contacting social service agencies and other local organizations to collect information on specific subgroups of the transportation-handicapped population will depend on the number of groups to be contacted and the degree to which such groups will cooperate with the survey team, the extent to which persons within the subgroups belong to any one organization, and the degree to which members are willing and able to supply requested information. Where the survey team is unable to directly contact clients of a particular social service organization, it may be possible to have the organization conduct the interview or distribute self-administered questionnaires to its clients, who can then complete the questionnaire and return it to either the social service organization or the survey office.

Ongoing Service Monitoring

The fourth element of the recommended data collection process consists of techniques for monitoring the use of public transportation services by transportation-handicapped people. These techniques include:

- developing and reviewing registration files of persons using specialized transportation service programs;
- performing periodic counts of transportation-handicapped passengers using these programs; and
- reviewing records of requests for or inquiries regarding specialized transportation services.

Each of these techniques involves developing and using an easily maintained data base to monitor and evaluate the use of public transportation services by transportation-handicapped people. This information can then be used by transportation planners and transit operators to fine-tune or revise their special transportation service programs.

The cost of monitoring the use of public transportation services by transportation-handicapped people depends on many factors, including the technique used, frequency of data collection, extent of data collected, and sample size. Registration files and service request or inquiry records are low-cost monitoring techniques, especially for those organizations already using them in special transportation service programs.

Implications of the data Collection Process

The data collection process described in this paper has several implications for local transportation planners and transit operators. These include the following:

- The overall process is comprehensive. Both primary and secondary data collection techniques are used to develop local subarea information on the number, location, characteristics, and transportation needs of transportation-handicapped people.
- The process develops statistically reliable estimates of local transportation-handicapped population characteristics, while also providing significant information on small subgroups of the transportation-handicapped population having specialized transportation needs.
- The process is adaptable to local planning needs and resources. Each of the techniques in the process can be tailored to the size of the local area and the resources available to collect data. The techniques represent the most cost-effective procedures for developing comprehensive and reliable information on local transportation-handicapped people.
- The process enhances the usefulness of census data concerning the transportation-handicapped population. The census data are used to distribute independent areawide data to the subarea (census tract) level. This avoids the problems of underrepresentation and data obsolescence which might result from using census data alone to estimate current incidence rates of transportation-handicapped people at the local level.
- The process is relatively simple. Sample sizes are provided in the detailed manual for the areawide telephone survey, based on the local area's popula-

tion, the confidence level of the estimate, and the relative error of the estimate. Screening and handicapped person interviews are conducted by telephone, thereby avoiding the costs and logistical problems associated with personal interviews and the poor response rates associated with mail-back questionnaires.

Data Collection Manual

Transportation service planners and providers will find much more detailed information as well as instructions on how to apply each of the individual data collection techniques described in this paper in a report entitled: Planning Services for Transportation-Handicapped People, Data Collection Manual. This manual provides step-by-step instructions, cost information, and supporting documentation for each of the recommended data collection techniques. It also contains detailed estimates of the areawide telephone survey sample sizes needed to estimate the incidence and daily travel rates of the local transportation-handicapped population. The appendices to the manual contain illustrative examples of survey forms used in studies which demonstrated each of the techniques used in the overall data collection process.

Copies of the data collection manual can be obtained by contacting one of the following:

Technology Sharing Program (I-30HD)
Office of the Secretary of Transportation
U.S. Department of Transportation
400 Seventh Street, S.W.
Washington, D.C. 20590

Title: Planning Services for Transportation-Handicapped People, Data Collection Manual (August 1983)
Document Number: DOT-I-83-40

National Technical Information Service (NTIS)
Springfield, Virginia 22161
Title: Planning Services for Transportation-Handicapped People, Data Collection Manual (August 1983)

Report Number: UMTA-DC-09-9049-83-1

Daniel L. Dornan, Manager, Peat, Marwick, Mitchell and Co., Washington, D.C., 20006.

David P. Middendorf, Associate Director, Transportation Center, University of Tennessee, Knoxville, Tennessee, 37996.

Richard P. Steinmann, Program Analyst, Office of Strategic and Energy Planning, Urban Mass Transportation Association, Washington, D.C., 20590.

A REGIONAL REDUCED FARE PERMIT FOR THE ELDERLY AND DISABLED

Barbara Dougherty and Edward McCormack

Public transportation agencies in the Puget Sound region of Washington State have instituted a regional reduced fare permit for elderly and disabled persons. Standard age and disability criteria among the several agencies have eliminated the need for elderly and disabled riders to apply for multiple permits in order to receive the reduced fare benefits of the respective agencies. The regional permit facilitates interagency and intermodal travel throughout the region for this segment of the public transportation market.

The Need For Regional Coordination

The Puget Sound region is located in the northwestern portion of Washington State. Seattle is the primary economic center of the four-county area which has a population of over two million. The topography of the region including several major water bodies, has constrained development and associated travel to a linear pattern rather than the radial pattern of most large urban areas. As a result, many daily trips traverse several jurisdictions served by a diversity of public transportation systems as shown by the accompanying map. Five public transit companies, Washington State Ferries, and the Seattle Monorail and Waterfront Streetcar operations comprise the region's public transportation network. All of these systems are federally assisted and are therefore subject to certain mandates regarding elderly and disabled accessibility. These include the provision that during non-peak hours, mass transportation services will be offered to elderly and disabled persons at no more than one half the normal peak hour fare.

TABLE 1

Transit Agencies Statistics (1983)

Agency	*Total Population Served*	*Fleet Size*	*Route Mileage*	*Passengers Carried (millions)*	*Operating Budget (millions)*
Community Transit	239,000	70	340	3.6	$ 8.5
Everett Transit	56,200	43	95	1.7	$ 3.2
Kitsap Transit	100,900	79	311	1.0	$ 3.0
Metro Transit	1,315,800	1,145	2,050	62.5	$107.6
Pierce Transit	417,400	184	345	11.5	$ 20.7

The region's public transit systems range from high density urban to low density rural operations. Table 1 shows the variations in service areas, ridership volumes, fleet sizes and operating budgets. Each of these systems operates independently under the governance of its respective board. No formal authority exists to dictate coordinated services or fares. As a result, the fare structures, transfer policies, hours of operation, reduced fare eligibility criteria and procedures, etc., vary widely. Nonetheless, there is a strong commitment toward voluntary interagency and intermodal coordination. Interagency contract services, transfer connections, and coordinated information mechanisms are important characteristics of the regional public transportation network.

Some of this interagency cooperation occurs at the initiative of two or more agencies. But at the regional level the key to such cooperative programs, as the Regional Reduced Fare Permit, is a formal, though voluntary forum of the public transportation agencies established under the Puget Sound Council of Governments (PSCOG). Each of the public transportation agencies in the region is represented on policy and technical committees of the PSCOG through which opportunities for cost-effective, cooperative programs are developed.

The need for a regionally coordinated reduced fare permit was identified in 1980 during the development of plans to meet federal regulations for elderly and disabled accessibility. The PSCOG surveyed the public transportation agencies to determine the range of eligibility criteria, procedures and reduced fare benefits for elderly and disabled persons. The results are displayed in Tables 2 and 3. The agencies collectively agreed that their strong commitment to provide services for elderly and disabled persons within their own service areas would be enhanced by regionwide standards that would facilitate intra-regional mobility.

TABLE 2

Comparative Eligibility Criteria

Agency	*Age Threshold*	*Extensive List of Medical Conditions*	*Brief List of Medical Conditions*	*Verbal Statement of Disability*	*Obvious Impairment*
Community Transit	62	*			*
Everett Transit	62	8			*
Kitsap Transit	62			*	*
Metro Transit	65	*			*
Pierce Transit	60		*		*
Ferry Ssytem	65	*			*

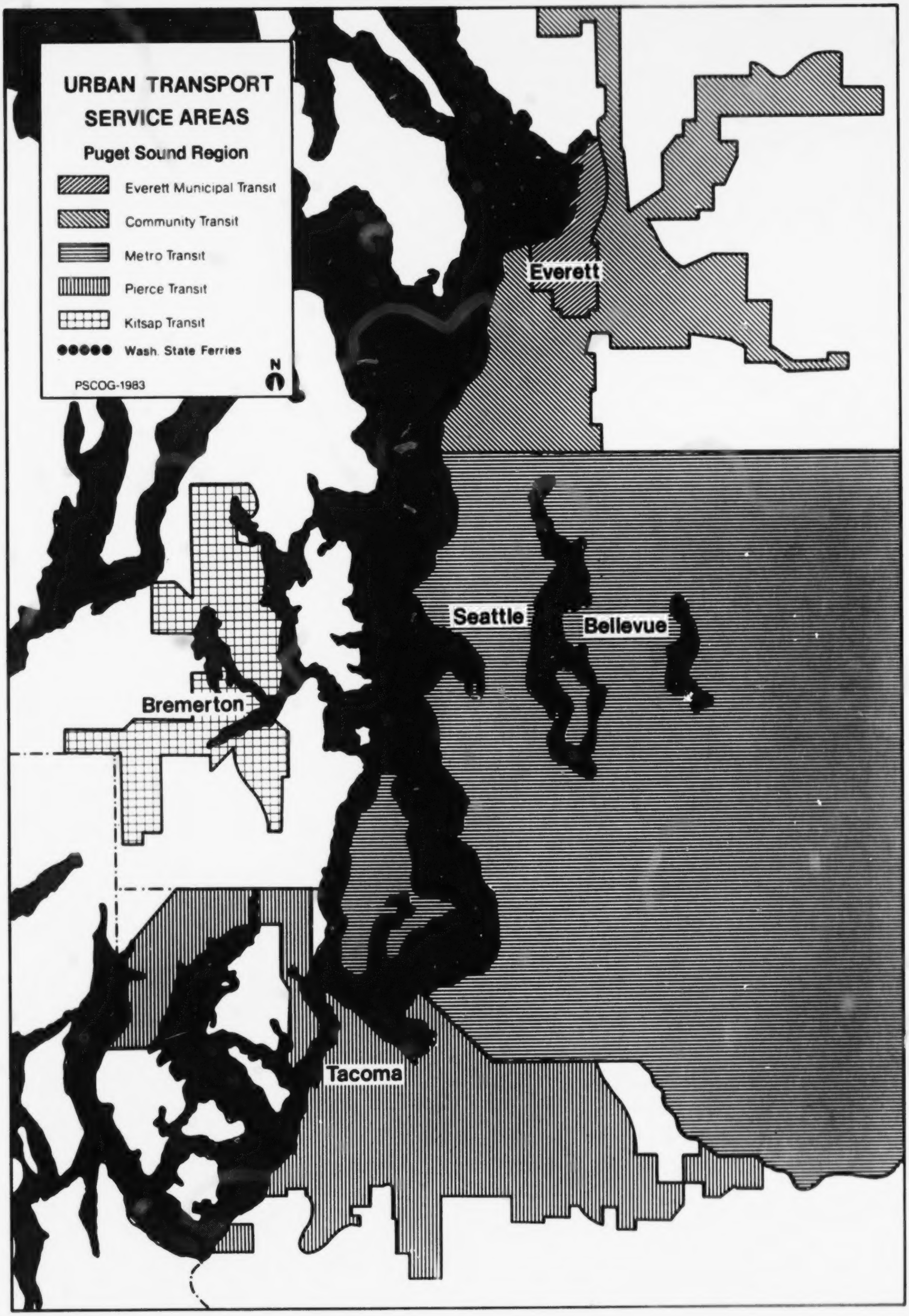

URBAN TRANSPORT
SERVICE AREAS
Puget Sound Region
Everett Municipal Transit
Community Transit
Metro Transit
Pierce Transit
Kitsap Transit
Wash. State Ferries
N
PSCOG-1983
Everett
Seattle
Bellevue
Bremerton
Tacoma

TABLE 3

Comparative Benefits

Agency	*Reduced Fare*	*Peak Period Use*	*Transfer Privilege*	*Reduced Fare Monthly Passes*
Community Transit	$.15 basic $.15/zone	no	no	no
Everett Transit	$.15 blind-free	yes	n/a	no
Kitsap Transit	$.25	no	n/a	$10.00 elderly $5.00 disabled
Metro Transit	$.15	yes	yes	$2.00
Pierce Transit	$.25	Only with monthly pass	yes	$10.00
Ferry System	half fare	yes	no	no

Evaluation Of Alternatives

Three basic approaches to creating a regional reduoed fare policy were evaluated through the interagency forum:

1. Mutual recognition of the reduced fare permits issued by the respective agencies. Since each of the transportation agencies had its own locally issued reduced fare permits, an obvious approach to regional cooperation was to institute common recognition of the permits among the agencies. However, potential revenue losses for systems with higher age thresholds and/or stricter disability criteria were too great. For example, the value of a reduced fare permit over that of a regular pass for Metro Transit could be as high as $400 over the period of one year. Because federal law prohibits the permitting agency from requiring evidence of residence in the service area, a person could conceivably apply for and obtain a permit from an agency with a lower age threshold or less stringent disability criteria and use it regularly for metro services at a considerable savings. This approach was thus eliminated from further consideraton.

2. Full integration of the reduced fare policies of the respective agencies. A regional policy on full integration of fares, eligibility criteria and benefits would require some of the agencies to either increase or decrease their age thresholds and/or disability criteria. Following extensive analysis of the financial implications it was found that potential revenue loss was again the major obstacle. The largest system, Metro, would suffer a substantial revenue loss if its age and disability criteria were lowered. On the other hand, smaller systems, which could effectively serve markets at lower age thresholds and less stringent disability criteria, would stand to lose existing riders and to suffer negative impacts on their public image by elevating these criteria. Even the concept of phasing in the reduced fare policy changes over a period of five years was not acceptable to some systems. This approach was eliminated also from further consideration.

3. Standard eligibility criteria for a regional reduced fare permit and preservation of existing permits for local use only. The decision to pursue an approach that would address regional objectives while preserving the local fare-setting autonomy of the respective agencies was the key to the ultimate success of the project. As long as the agencies could continue to issue local permits for use within their own service areas, the negotiation of standard criteria for an interagency permit could progress. Agreement was reached to select the higher age threshold and more stringent disability criteria in use at the time for the issuance of the regional permit. This approach eliminated the potential revenue and ridership losses that prevented agreement on full integration. While some considered that full integration should still be the goal, it was recognized that the greatest public need would be served, at least at the present time, by not excluding existing beneficiaries of reduced fare programs.

Under the combined approach, an elderly or disabled person who meets the criteria established for the regional permit is entitled to pay the amount of the reduced fare in effect in each of the service areas through which he/she travels. Time-of-day restrictions and transfer policies established by the local agencies are not affected by the regional policy. A person who does not meet the regional criteria but who meets the lower age threshold or disability criteria of the agency in his/her own area may still obtain a locally issued permit for use in that area. In either case, the permit is essentially an identificaton card that is used as proof of eligibility to pay the reduced fare when boarding a vehicle, or to purchase a monthly pass at reduced rates where offered.

Memorandum Of Agreement

The formal mechanism for instituting the Regional Reduced Fare Permit is a memorandum of agreement prepared by the PSCOG through the interagency forum. Once finalized, the agreement was formally adopted by the governing boards of the public transit agencies and by Washington State Ferries. The agreement establishes the eligibility and permitting procedures; the design, printing and distribution of the permit; and the preservation of local reduced fare programs.

The disability criteria and permit procedures of the respective transportation agencies were compared and evaluated in light of federal requirements. Agreement was reached on granting eligibility on the basis of one or more of six conditions:

—Proof of age, 65 years or older.

—Proof of current eligibility for Social Security disability benefits or current receipt of Supplemental Security Income Benefits.

—Proof of current disability certification of 40 percent or more by the Veterans Administration.

—Valid Medicare card issued by the Social Security Administration.

—Certification by a physician licensed by the State of Washington as meeting one or more of several detailed medical criteria contained in a compendium attached to the agreement.

—Obvious manifestation of one or more of the criteria listed in the compendium as, for example, a multiple amputee.

The agencies also agreed that temporary regional reduced fare permits could be issued. An individual who has an impairment expected to last for a continuous period of not less than three months but where improvement at a future date may reasonably be expected to occur, may apply for a temporary permit which will be valid for up to one year.

Design And Implementation of Permit

Permit Design.

The design of the Regional Reduced Fare Permit was an important item of negotiation and necessitated the direct involvement of marketing and operations representatives of the respective agencies. Vehicle operators and ticket takers were already required to recognize numerous local permits and passes. Therefore, the design of the regional permit had to be distinctive and enable quick determination of validity. The physical characteristics of each of the locally issued permits was evalauted and a design was developed. The credit card size permit bears the following features:

—unique title and colored band to facilitate driver recognition

—name of authorized user

—photograph of authorized user

—list of transportation systems on which the permit may be used

—serial number

—expiration date (on temporary permits only)

Printing and Distribution.

Several alternatives for producing, printing, and distributing the permit to the public transportation agencies were considered. Obvious possibilities included a pooling or reimbursement of funds from the respective agencies with either the PSCOG or one of the transportation agencies assuming these functional responsibilities. But as demonstrated in many ways throughout this project, as in other regional efforts, the direct involvement of the State Department of Transportation (DOT) was a key factor in the project's success. The State DOT produced, printed and distributed pre-determined quantities of the permits to the participating agencies. The volume printed was based on an estimate of need for three years. Each agency was issued a batch of permits with a unique set of serial numbers to facilitate independent recordkeeping.

Issuance and Operation.

Full responsibility for marketing and issuing the Regional Reduced Fare Permit lies with the respective public transportation agencies as part of their own programs. Administrative and operational personnel are trained in the proper issuance and use of the permit. The issuing process requires the agency to provide physician certification forms, to assess proof of eligibility, to complete the permit and to maintain a record of permits issued. The issuing agency types or prints the individual's name on a file card, a portion of which is photographed simultaneously with the individual. The image is reduced in size and the final product is laminated. The individual is charged a $1.00 fee for the permit which is issued immediately. Lost or stolen permits may be replaced through the same process.

In some areas, agencies conduct outreach efforts at senior centers or institutions for the disabled where a number of potential riders may be issued permits. In other cases, selected social service agencies are authorized to issue permits on behalf of the transportation agency. This necessitates mutual trust among the transportation agencies that each will ensure proper fulfillment of its obligations and necessary precautions against fraud.

Issuing agencies must have access to an I.D. Card Cammra to reduce the file card image while photographing the rider. Plastic laminating equipment is also required. The cost for the necessary camera equipment is in the $1800 to $2600 range. For smaller transportation agencies, this expenditure may not be feasible. Thus, some agencies in this region are borrowing or sharing equipment with other local government offices. In these cases, the days and hours during which permits may be obtained are designated and publicized.

Potential For Future Expansion

Several opportunities exist for expansion of the Regional Reduced Fare Permit. Even before it was finalized in its present form, three transit agencies in counties adjacent to the four-county region expressed interest in participating in the program and added their names to the Memorandum of Agreement. Over time, it may be found that a statewide permit may be desirable and feasible. In this case, coordinating roles would shift from the regional level to state organizations including the Washington State Department of Transportation and possibly the Washington State Transit Association. Other future directions might include efforts toward full fare and service integration and incorporation into monthly pass programs for frequent interagency travel.

Summary Of Key Factors

The successful negotiation of the Regional Reduced Fare Permit for elderly and disabled persons was dependent upon a number of factors. These have all been covered in detail above but are summarized here in considering transferability to other areas.

1. Strong commitment on the part of the public transportation agencies toward increasing mobility for elderly and disabled persons.

2. Voluntary cooperation among the respective transportation agencies through a formal mechanism with sufficient staff support to conduct the necessary surveys, prepare agreements and assist in negotiations.

3. Direct involvement of governing board members, managers, and operations and marketing representatives of the participating agencies.

4. Openness to approaches that meet regional needs without negatively impacting existing ridership and the fare-setting autonomy of the respective parties.

5. Financial support or contributed services from the State Department of Transportation.

6. Flexibility and adaptability to revise and/or expand the program following a demonstration period.

Barbara Dougherty, Public Transportation Coordinator and Edward McCormack, Transportation Planning Intern, Puget Sound Council of Governments, Seattle, Washington 98104.

A COMPARISON OF FIVE EXEMPLARY TRANSPORTATION SERVICES FOR THE DISABLED

Carol T. Everett

Introduction

On September 9, 1983, the U.S. Department of Transportation issued new proposed rules under Section 504 of The Rehabilitation Act of 1973 (48 Federal Register 40784). These proposed rules allow transit agencies to provide paratransit or special services in lieu of accessible fixed-route services. They also set criteria which would govern the nature and level of specialized services offered by transit agencies. These service criteria require that:

- geographic coverage, service times, and fare levels be comparable to fixed-route service;
- no restrictions be imposed on trip purpose; and
- reasonable waiting times be established.

In addition, the rules proposed for the first time a "cost limit" on the amount of funds local jurisdictions are required to spend annually in achieving the minimum service criteria. Jurisdictions can spend less than this cost limit if all the service criteria are met, or more than the cost limit if they wish to do so. However, they are not required to spend more than their annual cost limit on complying with the U.S. DOT rules.

These proposed changes signal increased flexibility to local communities considering how best to provide transportation services to their disabled citizens. This paper gives planners and decisionmakers in these local communities guidance on how to consider the potential implications of the major alternative service strategies.

Communities have chosen many ways to address the transportation needs of the disabled. These approaches vary along a number of dimensions including:

- the combination of accessible main-line service and paratransit service provided;
- the level and type of transit agency and private provider involvement;
- the amount of social service agency participation as providers and/or as subsidizers;
- the mechanisms used to pass subsidies to the providers;
- the degree of centralized dispatching and control involved; and
- the overall level of service provided (fares, reliability, responsiveness, and "rationing devices").

In this paper, five exemplary services are described and compared: two are accessible main-line services (Seattle, Washington, and Champaign, Illinois), and three are paratransit services (Milwaukee, Wisconsin; Pittsburgh, Pennsylvania; and Lancaster, Pennsylvania). These five exemplary services were chosen for study for three basic reasons:

- They are of interest to other localities because they have had relatively high ridership and good reliability.
- They represent very different demand and operating environments.
- They have been monitored quite carefully during their implementation by the Urban Mass Transportation Administration (UMTA). As a result, it has been possible to develop consistent measures of benefits and costs using standardized methods and assumptions.

This paper begins with a description of the distinguishing characteristics of each of the five services and then compares them in terms of costs, benefits, and service levels.

Five Exemplary Services

Accessible Fixed-Route Bus Services

Transit authorities' experience with lift-equipped fixed-route bus service has varied enormously around the nation Two communities which have documented positive experiences are Seattle, and Champaign.

Seattle's accessible fixed-route bus service has been the most heavily used service of its type in the country.[1] In 1983, Seattle Metro operated 259 lift-equipped buses on 43 routes and had an average of 113 lift boardings per day. A 1981 study of accessible fixed-route bus services found that Seattle's cost per boarding was the lowest in the nation—only $16 compared to hundreds of dollars per user for other systems.[2] The city has had an exceptional service record and high on-time performance compared to other systems. Also of interest is that the service is part of a larger "hybrid" approach to addressing the needs of Seattle's disabled, which includes a Metro-administered specialized transportation service for the elderly and handicapped.

---

[1] Crain and Associates, "Lift-Equipped Bus Service for Seattle, Washington," Draft Final Report, Transportation Systems Center, Washington, D.C.: U.S. Department of Transportation, 1981.

[2] Casey, R.F., "The Accessible Fixed-Route Bus Service Experience," Report No. UMTA-MA-06-0049-81-7, Transportation Systems Center, Washington, D.C.: U.S. Department of Transportation, 1981.

Champaign represents an entirely different demand and operating environment from Seattle.[3] It is a medium-sized urban area, with a young university-oriented population and cold Midwestern winters. Champaign's Mass Transit District (MTD) was selected to be an UMTA demonstration site to test the feasibility of a fully accessible bus system in a cold weather climate. The MTD was not able to achieve full accessibility on all of its ten routes during the demonstration because of problems encountered with retrofitting its existing vehicle fleet.[4] However, on the three routes which were made fully accessible, the service recorded the highest lift usage as a proportion of total ridership (0.13 percent) of any accessible fixed-route bus service that has been evaluated by UMTA to date. Champaign's MTD, like Seattle Metro, also administers a complementary specialized service for the elderly and handicapped.

Special Services

Because of the flexibility inherent in paratransit services, there is more room for diversity in the way special services for the handicapped (compared to fixed-route accessible services) are organized, administered, and operated. Services operated by Milwaukee, Wisconsin; Pittsburgh, Pennsylvania; and Lancaster, Pennsylvania demonstrate this point effectively.

Milwaukee's special service employs a "user-side subsidy" approach to providing door-to-door services to the eligible disabled.[5] This user-side subsidy mechanism differs from the more frequently encountered approach which grants subsidies to providers of transportation services. Under user-side arrangements, subsidies in the form of discounted tickets or charge slips are issued to eligible users. Each user is then free to patronize the provider of his or her choice, with the provider redeeming used tickets or charge slips for their full value from the subsidizing agency. Providers, thus, receive full subsidies for the trips they serve rather than for maintaining a specified level of service. (Seattle and Champaign's special services cited above both utilize the user-side subsidy approach.)

Milwaukee's service represents one of the largest applications of the user-side approach nationwide. It has been so successful that in 1982 it led the plaintiffs in a 1976 suit urging main-line accessibility to drop their action and to allow the transit agency to stop operating lifts on 250 buses. In return, Milwaukee has committed itself to continued funding for the paratransit/user-side subsidy service at a level equal to 2.2 percent of the transit system's operating budget.

The service has been credited with improving wheelchair van service—increasing hours of service, permitting more service flexibility—through its stimulation of provider competition. As a result of its positive effects, Milwaukee's special service has received a great deal of national attention—in September 1983, in the U.S. Department of Transportation's proposed final Section 504 rules. These rules single out Milwaukee's program as one that appears to meet many (though not all) of its proposed service criteria at a cost that does not impose an undue financial hardship.

Pittsburgh's special service, while using the more traditional providerside approach to subsidy disbursement (i.e., service is contracted on a per mile or per vehicle hour basis), has received high visibility nationally because of its centralized approach to service management.[6] In Pittsburgh, the regional transit authority hired an independent organization to design, market, administer and contract for door-to-door services. This organization neither operates nor subsidizes any of the services. The approach's objective is to minimize per-trip costs by matching the demand for, and existing supply of, paratransit services in such a way as to maximize opportunities for ridesharing. The matching agent, called ACCESS, uses a competitive bidding process to select providers, which in this case includes taxi operators and human service agencies.

ACCESS markets its transportation services to all human service agencies, and assists the 45 participating agencies in scheduling their clients' trips. About half of all ACCESS trips are agency-sponsored, and provided at no cost to the rider. ACCESS also sells two types of scrip. The first, sponsored by the transit authority, provides an 89 percent fare discount on ACCESS to persons who are not associated with a social service agency and cannot use mass transit because of a physical disability. The second, administered by the Pennsylvania Department of Transportation and funded by the state lottery, provides persons 65 years and over a 90 percent ACCESS fare discount.

---

[3] Crain and Associates, "Accessible Fixed-Route Bus Service in Champaign Urbana, Illinois," Report No. UMTA-IL-06-0039-84-1, Transportation Systems Center, Washington, D.C.: U.S. Department of Transportation, 1983.

[4] Since the preparation of this Chapter, Champaign has achieved 100 percent accessibility on all of its routes.

[5] Charles River Associates, "The Milwaukee County User-Side Subsidy Program: A Case Study," Report No. UMTA-MA-06-0049-82-4, Transportatio Systems Center, Washington, D.C.: U.S. Department of Transportation, 1982.

[6] Charles River Associates, "Paratransit Brokerage Demonstration Project: Pittsburgh, Pennsylvania," Final Report, Transportation Systems Center, Washington, D.C.: U.S. Department of Transportation, 1983.

TABLE 1

Level of Service Compared to General Public Systems for Five Exemplary Disabled Transportation Services

	Geographic Coverage	*Time Availability*	*Fares*	*Trip Purpose Restrictions*	*Waiting Time*	*Waiting Time*
Fully-Accessible Strategies						
Seattle	smaller	same	lower	none	intervals in scheduling service	none
Champaign	smaller	same	lower	none	intervals in scheduling service	none
Special Services Strategies						
Milwaukee	greater	greater for taxi service; less for van service	higher	none	48 hours advance notification for van services; immediate service for taxi users	none
Pittsburgh	greater	approx. same	approx. same	none	24 hours advance notification	none
Lancaster	smaller	approx. same	approx. same	none	24 hours advance notification	none

Lancaster has a much smaller, more predominantly rural population than either Pittsburgh or Milwaukee.[7] Its system is interesting because it has combined key elements of both the large city programs. That is, it has adopted a centralized approach to service management as well as a user-side approach to subsidy disbursement. To administer the system, Lancaster has established a nonprofit organization that selects providers competitively for various sectors of the region and then markets the services to area social service agencies. (This is similar to Pittsburgh's centralized service management approach) But instead of paying providers on a vehicle service hour or hourly rate basis as in Pittsburgh, carriers are paid on a per trip basis as in Milwaukee.

Users receive tickets from social service agencies, who distribute them for the most part free of charge to clients. Handicapped individuals not affiliated with social service agencies who are unable to use public transportation receive trip tickets for 80 cents, with the regional transit authority funding the balance of individual trip costs. The Pennsylvania Department of Transportation subsidizes senior citizen trips as it does in Pittsburgh.

A Compartive Analysis

In the following pages, the five exemplary services are compared along three dimensions: service levels, mobility benefits, and cost-effectiveness.

Service Levels

One major question that arises with any service tailored to the specialized needs of individual population groups is how well it "performs" when compared to similar services available to the general public. The six service criteria set out in DOT's 1983 regulations provide one set of performance standards. These criteria require comparability between special services and general public services in the areas of geographic coverage, time availability, fares, trip purpose restrictions, waiting time, and waiting list. Table 1 examines how closely the three special services and the two fixed-route accessibile services match their general public counterparts along these six dimensions.

The most interesting finding this comparison offers is that none of the handicapped services, not even the lift-equipped fixed-route services, is completely comparable to its general public "main-line" counterpart. While the lift-equipped bus services in Seattle and Champaign are exactly the same as their general public counterparts in most respects, the services differ significantly in two ways. First, the geographic coverage of lift-equipped buses is much smaller than that of regular bus operations. Only about 50 percent of each community's bus routes are currently accessible, although both plan to eentually make all their routes accessible.

Second, while there are no advance reservation requirements to obtain accessible bus service, lift-equipped vehicles are scheduled at longer intervals than their regular service counterparts. One area where the accessible fixed-route services are "superior" to their general public counterparts is fare levels: significant fare discounts are provided handicapped bus riders in both Champaign and Seattle.

---

[7] Charles River Associates, "Lancaster Elderly and Handicapped Transportation Brokerage: A Case Study," Draft Final Report, Transportation Systems Center, Washington, D.C.: U.S. Department of Transportation, 1983.

The exemplary paratransit efforts examined also match their main-line counterparts quite closely in terms of most service quality indicators. A clear exception, though, is the advance reservation requirements they impose. While the Milwaukee, Pittsburgh, and Lancaster services try to fit in on demand requests, they all require advance notification for guaranteed service ranging from 24 to 48 hours.[8] Aside from this, though, the special services perform comparatively well—maintaining no waiting lists and imposing no trip purpose restrictions—and, in some instances, exceeding main-line services in terms of geographic coverage and time availability.

Mobility Levels

Another important issue is the amount of mobility each service provides the disabled. What percentage of the total eligible handicapped population in each community actually use the accessible bus or special service?; And for what proportion of its total trips? Are these services creating new trips, or are they replacing trips which would have been made anyway by other means? While the data in the UMTA evaluation reports do not give enough information to answer all of these questions directly, they do allow one to make some generalizations about the market for disabled transportation services.

The most interesting finding is that a relatively small number of transportation handicapped account for a surprisingly high share of each service's use; that is, the market pentration of disabled services is small. Table 2 shows that, except for Milwaukee's special service, none percent or fewer of those elegible for an area's exemplary disabled service are registered for or actually use the service. While 40 percent of Milwaukee's eligible population is registered to use the paratransit service, about four percent of those registrants account for much of the system's volume—taking between 30 and 40 trips each per month.

Another finding is that the different subgroups of the disabled prefer different types of service; that is, the market for disabled services is highly segmented. For example, younger handicapped persons who need less assistance in getting around outside the home make up the overwhelming majority of accessible fixed-route bus service users.[9]

These two findings—small market penetration and high market segmentation—are consistent with other research that has shown that the transportation needs of the handicapped are highly heterogeneous.[10] This heterogeneity accounts for the fact that some cities, such as Seattle and Champaign, which are fully committed to making fixed-route transit accessible to the handicapped, have also chosen to continue specialized door-to-door services for elderly and handicapped persons for whom accessible transit is still too inconvenient. While fully accessible transit services may satisfy statutory and regulatory requirements, they will not meet all the travel needs of the varied handicapped population. As a result, hybrid solutions incorporating a mix of accessible main-line and door-to-door service, such as those of Seattle and Champaign, may be the most effective transit solutions for many urban areas.

Cost-Effectiveness

Much of the debate on handicapped transportation has centered on the issue of costs and cost-effectiveness. Using the UMTA evaluation reports, The Urban Institute has assessed the five exemplary services over a common five year program period, expressing all monetary estimates in 1980 dollars. Table 2 provides cost data that transit agencies considering establishing similar programs could use to calculate each service's average total cost per trip, revenue generated and net program cost per trip.

These data show that under the right conditions, and with good planning and operation, each service approach can be relatively cost-effective and reliable. For example, if a larger transit agency, today, were to institute an accessible bus service such as Seattle's, it could expect to incur an average total cost per trip of approximately $7.50 (in 1980 dollars). If it were interested in instituting a paratransit system similar to Milwaukee's user-side subsidy program or Pittsburgh's brokerage program, the corresponding per-trip costs would be approximately $8.90 and $10.60, respectively.

Conclusion

On the basis of The Urban Institute's work in this field, it appears that a major ingredient for success is a commitment to making the service work regardless of the service approach selected. In Seattle, for example, the Metro Council decided to pursue a policy of lift-equipping all of its transit vehicles several years before U.S. Department of Transportation regulations were published requiring full accessibility. The commitment to full accessibility is reflected in Seattle's comprehensive approach to installing lift-equipped service, which included making bus stop improvements, carefully selecting routes for accessible service, undertaking broad marketing and outreach, and providing reliable back-up service in in-

---

[8] In Milwaukee, disabled persons who can use a taxi have the same reservation requirements as other members of the general taxi riding public.

[9] See (1) and (3) above.

[10] Michael Fix and Carol Everett, "A Report to the Pew Foundation," 1984.

TABLE 2

Cost/Benefit Assessment for Five Exemplary Disabled Transportation Service

	Fully Accessible Services		*Special Services*		
	*Seattle**	*Champaign*	*Milwaukee**	*Pittsburgh**	*Lancaster**
I. Demographic Characteristics					
Eligible users	1,850	378	12,200	30,300**	766**
Eligible users registered	5 percent	9 percent	40 percent	1 percent	6 percent
Total population (1980)	1,269,749	110,000	965,000	1,450,000	157,385
II. Program Characteristics (annual)					
Trips served	24,200	1,835	112,000	78,400	7,100
Program cost	$178,500	$41,505	$865,800	$724,40	$13,900
III. Performance Measures					
Total cost per trip	$7.52	$22.80	$8.91	$10.62	$2.81
Revenue per trip	.15	.18	1.26	1.38	.85
Program cost per trip	7.37	22.62	7.65	9.24	1.96

Note: Costs are expressed in 1980 dollars and all costs and benefits (including trips) are present values obtained by using a 10 percent discount rate over a five-year program period. The UMTA evaluation reports provided the base data for these calculations.

* ***SOURCE:*** Ronald F. Kirby and Gerald K. Miller, *A Case Book of Short Range Actions to Improve Public Transportation*, prepared for the Office of Management, Research and Transit Services, February 1983.

** These are the number of persons eligible for transit agency sponsorship; other individuals are also eligible to use these special services, but through a nontransit funding source.

stances of mechanical or other failures. This commitment and comprehensive approach to implementation seem to be missing in those communities that have had disappointing results with their lift-equipped main-line service.

A community's commitment to accessible main-line service does not appear to be one which is based purely on principle, however, and those communities which have developed successful systems seem to have had other factors working in a contributory direction. For example, in Seattle, a significant proportion of its bus fleet was scheduled for replacement when the lift-equipped option was raised. Seattle Metro viewed it as cheaper in the long run to provide accessible main-line service and to encourage "mainstream" than to provide door-to-door service to its entire transportation handicapped population.

Another factor which appears to contribute to a community's commitment to accessible main-line service is the existence of major rehabilitation facilities or services geared to helping the disabled person become more independent. For example, Champaign's unusually large and active handicapped population is explained by the presence of a nationally known rehabilitation/education program at the local state university. The program has stimulated the remodelling of a large number of public buildings to accommodate wheelchairs, an aggressive curb-cutting campaign, and the provision of an accessible fixed-route shuttle bus service on campus.

A factor that may not be as important as originally thought is weather. Evaluation data from Champaign shows that month-to-month demand for lift-equipped service varies surprisingly little and that throughout the year lift denials due to equipment malfunctions are only about 1.7 percent of total attempted lift boardings.[11]

A characteristic that is similar for all the service types is relatively low demand density; that is, for any given geographic area and time period, only a small number of trips are made. This characteristic makes ride sharing difficult, resulting in overall costs per passenger trip and per passenger trip mile that are quite high by comparison with home-to-work and general purpose travel.

The most cost-effective service approach for a community will depend upon its specific objectives as well as its local demand and supply conditions. In some cases, the "best" approach will be a wholly accessible main-line approach (Johnstown, Pennsylvania is an example), in others, a wholly paratransit approach (such as in Milwaukee and Lancaster), and for some places (such as Seattle and Champaign), a combination or hybrid approach may prove most effective. Finally, an "open options" approach - such as that adopted by Pittsburgh—where paratransit is used now but full accessibility is not foreclosed as a future service approach, could prove a cost-effective long-run strategy. While Pittsburgh currently relies upon a door-to-door service for those individuals who cannot ride main-line transit, it is "building in" accessibility incrementally as it makes major new capital investments in transportation.

---

[11] Crain and Associates, "Accessible Fixed-Route Bus Service in Champaign-Urbana, Illinois," Report No. UMTA-IL-06-0039-84-1, Transportation Systems Center, Washington, D.C.: U.S. Department of Transportation, 1983.

Acknowledgement

This paper is based primarily upon work conducted for the Pew and ARCO Foundations. The benefit and cost data were produced as part of work conducted for the U.S. Urban Mass Transportation Administration under contract DOT-UT-90052. I wish to thank Michael Fix and Gerald Miller of The Urban Institute for their helpful suggestions and comments. The opinions are the author's and do not necessarily represent the views of The Urban Institute or its sponsors.

Carol T. Everett, Research Associate, The Urban Institute, Washington, D.C. 20037.

THE EVOLUTION OF TRANSPORTATION PROGRAMS FOR THE DISABLED IN THREE PENNSYLVANIA CITIES

Michael Fix

Introduction

This paper will examine evolving efforts to deliver transportation services to the disabled in three Pennsylvania cities: Philadelphia, Harrisburg and Erie.[1] It may be useful to understand how a set of fiscally pressed, cold weather urban jurisdictions, have grappled with the problem of meeting the transportation needs of the disabled within the dynamic policy environment of the past and current decades.

The paper is divided into four sections. The first section chronicles briefly the development of programs in each jurisdiction up to 1981, when the Reagan Administration rescinded the 1979 federal full accessibility regulations promulgated by the Carter Administration. The second section examines the paratransit efforts in these three sites with those in the "exemplary" sites surveyed in my colleague Carol Everett's paper which appears elsewhere in this volume. It also provides some observations on the changing character of the three programs. The fourth section offers some concluding comments.

In general, four observations can be made about the evolution of efforts to provide the disabled with transportation in the three sites:

- Initial activity was spurred in each case by federal regulatory requirements;
- Virtually no efforts to provide the disabled with public transportation were made before federal full accessibility regulations appeared imminent—despite the fact that substantial federal regulatory activity had taken place well before that time;
- After proposing fully accessible fixed route approach in response to federal regulations each jurisdiction has "fallen back" to a paratransit emphasis in the wake of the Reagan Administration's rescission of federal full accessibility rules; and
- At the current stage in each program's development, none operates a program which complies with cost and performance standards set out in recent federal regulations.

The Case Study Sites and Their Transportation Programs

From a demographic and fiscal perspective, Philadelphia, Harrisburg and Erie resemble one another quite a bit—despite their differing population sizes. In terms of demographics, each has suffered continuing population losses throughout the past decade and supports a population which is older than the nation as a whole (indeed Pennsylvania has the second oldest population in the nation).[2] From a fiscal perspective each of the sites has faced sustained fiscal problems over the past decade; problems which have been reflected in declining tax bases and rising transfer payments.

But while the three jurisdictions' fiscal and demographic profiles are similar, their transit systems are quite different. Philadelphia is served by the Southeastern Pennsylvania Transportation Authority (SEPTA). SEPTA oversees a vast, multi-modal transportation realm—one which covers an area of approximately 2200 square miles and contains a population of approximately 3.7 million people. The third largest transportation authority in the nation, SEPTA operates a complex network of bus routes, rapid transit/subway lines, trackless trolley routes and a regional rail network. The system, which carriers more than a million passengers a day, serves the city and county of Philadelphis, as well as four neighboring counties: Chester, Bucks, Montgomery and Delaware. The system has experienced constant fiscal pressures over the past decade and has been recently reported to be running a $20 million deficit.[3]

SEPTA's efforts to provide specialized transportation service to the 79,000 transportation-handicapped people who live within the city of Philadelphia[4] include the operation of a paratransit service and 450 lift-equipped buses (out of a total fleet of 1600).

The transit systems in place in Erie and Harrisburg are quite small by comparison. Erie's Metropolitan Transit Authority (EMTA) operates a fleet of 77 buses, eight of which are lift-equipped. The main thrust of EMTA's efforts to provide transportation to the 3300 transportation handicapped population[5] is a paratransit program which is independently administered by a council representing the social service and disabled agencies.

---

[1] For the purposes of this analysis the "sites" examined represent that portion of each transit agency's urban service area within which transportation is provided to the disabled. Hence, despite the fact that SEPTA's service area extends far beyond the city of Philadelphia, as it only provides service to the disabled within the city's boundarie we have used the city as our unit of analysis.

[2] 1980 Census of Population. Supplementary Report, Series PC SO-S1-1, U.S. Department of Commerce.

[3] See "140 Hurt Near Philadelphia On Chronically Ill Railroad." The New York Times, November 22, 1984, A-16.

[4] 1980 Census of Population; General Social & Economic Characteristics of Pennsylvania, U.S. Department of Commerce, Table 123, p. 297.

Harrisburg's Capital Area Transit (CAT) operates a mid-sized 70 bus fleet. Economically stable because of conservative management practices, CAT serves the City of Harrisburg, Dauphin and Cumberland Counties. Like Erie, the main thrust of CAT's efforts to provide transportation to the 1700 transportation handicapped persons in its service district[6] is a paratransit program operated by the transit authority as a separately incorporated entity—Susquehanna SET.

The central purpose, then, of this paper is to examine how the character of transportation programs for the disabled have changed through time in these sites and how those changes "map" against the background of shifting federal regulations.

Historic Background

As late as fall 1976, none of the three transit agencies had taken any significant steps towards providing transportation for the disabled—despite increased federal assistance, the enactment of legislation calling for "special efforts" in the planning and design of transportation facilities serving the disabled,[7] and the passage of Section 504 of The 1973 Rehabilitation Act.[8]

However, in the fall of 1976 things began to change. Members of the Philadelphia chapter of Disabled in Action (DIA) were approached by attorneys from the Public Interest Law Center of Philadelphia. The lawyers wanted to make DIA members aware that the U.S. Department of Transportation (DOT) was considering scrapping what at that time was an obscure project to develop an accessible bus—the Transbus. The Transbus was thought to represent an important advance in bus design—one aspect of which was its accessibility to the physically handicapped. When, as the lawyers predicted, DOT later cancelled Transbus, DIA sued the DOT, claiming its action effectively discriminated against the disabled. The suit, which was one of the first to challenge federal transportation policies for the disabled, served notice on SEPTA that its actions would be intensively scrutinized by the local public interest law and disabled communities. It also served notice that the agency's approach to providing transportation for the disabled should embrace the concept of fixed route accessibility.

After Democrats won the 1976 presidential election, the Carter Administration, under substantial pressure from disabled groups revived the project. The then Secretary of Transportation issued a policy statement declaring that local transit authorities would have to purchase buses built to the Transbus design once they became available.[9] After the new policy's announcement the DIA suit was found moot and dismissed.

In the wake of the Secretary's order, and under pressure from its own elderly and handicapped advisory committee (as well as Disabled in Action), SEPTA became the first transit authority in the nation to commit itself to purchasing buses built to the fully accessible Transbus design, eventually leading a consortium of buyers which included agencies from Miami and Los Angeles.

With the Transbus option having been settled, and with the precise dictates of pending federal full accessibility regulations still unclear, SEPTA moved cautiously in making other commitments in the area. The Authority agreed to build accessibility into the construction of several proposed fixed facilities including The Center City Commuter Rail Connection and the Airport High Speed Line. In addition a number of minor system alterations were made such as the placement of wheelchair securements on a number of rail cars. But beyond these steps the Authority's major commitment to providing the disabled with transportation remained the Transbus.

Problems developed over time though, when progress on Transbus' development stalled while a number of design issues were being resolved. A full two years later, in May 1979, it was first learned that no manufacturer would be willing to build a bus to the federal design standards and that the project would have to be abandoned—leaving SEPTA empty handed.

Just as the stimulus for SEPTA's pathfinding commitment to providing the disabled with accessible transportation derived from external legal pressure based on federal regulatory pronouncements, efforts to provide public transportation to the disabled in Erie and Harrisburg were also driven by federal regulatory pressure. However, in both Erie and Harrisburg, the community's first efforts to develop a transportation program came somewhat later in time—in part, perhaps, because neither had a public interest legal agency similar to the one in Philadelphia.

Erie, unlike Harrisburg, started its current paratransit effort in 1978 before the promulgation of federal full accessibility regulations.[10] At that time a coalition of social service agency representatives approached the transit agency proposing that they work together to establish a paratransit service which would respond to federal rules. The transit agency accepted the offer and despite some internal debate within the city's disabled community over the relative merits of a fixed route versus a paratransit approach, a demand-responsive paratransit system was established. Indeed, the program begun then remains virtually unchanged today.

---

[5] Ibid.

[6] Ibid.

[7] See generally P.L. 91-453, 84 Stat. 962, October 15, 1970 and Section 165 (b) of the Federal Aid to Highway Act, 23 U.S.C. Section 142.

[8] Rehabilitation Act Amendments of 1974, P.L. 93-516, Section 111 (a), 88 Stat. 1617. While Congress' concerns had been forcefully expressed its will had yet ot be fleshed out by DOT in comprehensive implementing regulations.

[9] See, generally, 49 CFR 609.

[10] The reader should bear in mind, though, that federal full accessibility regulations had been announced in 1977 when the Department of Health, Education and Welfare issued "generic" regulations interpreting Section 504 of the Rehabilitation Act.

Of the three jurisdictions, only Harrisburg's Capital Area Transit did not participate in any way in providing public transportation to the disabled prior to the May 1979 publication of the final full accessibility regulations under Section 504. CAT's early involvement which began in late 1979, consisted of providing modest support to an independent paratransit service for the disabled — Wheels Incorporated. Soon thereafter Wheels went bankrupt leaving the region's disabled with no effective transportation service.

Responding to DOT's 1979 Full Accessibility Regulations

The target sites responded to federal full accessibility in three ways—with strong protests, detailed plans and modest programs.

Protests

Given the modest efforts in place, the prospects of being forced to comply with federal full accessibility regulations were both daunting and unwelcome for the three transit authorities—a fact they did not hesitate to make known. The Chairman of the Erie County Council on Transportation for the Elderly and Handicapped attracted nationwide attention when he appeared before a U.S. Congressional House Subcommittee in April 1980 to protest the disruptive impact the regulations would have on the operation of the city's paratransit system.[11] In his testimony he claimed that a survey of all wheelchair-bound individuals known to the Council had found unanimous opposition to the use of lifts.

Although neither Harrisburg nor Philadelphia's resistance drew the nationwide attention that Erie did, their objections were comparably strong. For example, the Boards of the Tri-County Regional Planning Organization and CAT submitted the following complaint to DOT:

> . . . Emphatic objection is hereby stipulated to both the method and costs mandated by the Federal Government requirements to which this Transition Plan is addressed.
>
> We object to the tactic of mandating a new expensive program under the threat of withdrawing funding support for existing programs.
>
> We object to the tactic of mandating a program which will generate larger costs without providing sufficient federal funding to support those costs and which will require large cost contributions by our local governments.[12]

SEPTA's objections to full accessibility were somewhat more muted in deference to the city's more active disabled community—many of whom supported a fully accessible transportation solution. SEPTA did, however, state that it was:

> particularly concerned about the impact of implementing such a plan and the burden it places on taxpayers, as well as riders, whether they are handicapped or not. More specifically, SEPTA's questions and concerns focus on the issues of operating costs, impacts on existing operations and present ridership (including possible indirect costs), technological feasibility of various proposals, safety, and handicapped utilization.[13]

Plans

As the foregoing suggests, in each of the three communities transit agency opposition to the full accessibility regulations was primarily based on costs. What were the costs that would arise from making all modes of public transportation accessible to the disabled? To answer this question we look to the extensive planning documents (Transition Plans) which each jurisdiction submitte to DOT after the rules were issued. The plans indicated the timing and character of the steps that would be taken up until the systems were fully accessible.

For example using cost estimates provided by management Harrisburg's CAT planned to:

- retrofit its existing bus fleet with lifts and/or acquire new buses with lifts, wheelchair tie downs and handrails until one half the system's peak hour fleet was accessible (cost: $15,000 per bus)
- undertake ongoing lift maintenance ($10,00 per year)
- conduct driver training ($12,000 one time cost);
- absorb increased insurance premiums ($25,000 per year);

---

[11] Statement of Michael Koncewicz, Chairman of the Transportation Council for the Elderly and Handicapped of Erie County, Pennsylvania before the Transportation Appropriations Subcommittee of the U.S. House of Representatives. April 15, 1980.

[12] Transition Plan for the Harrisburg Area: Accessibility for the Handicapped in Public Transportation, May 1980, The Tri County Regional Planning Commission, Capital Area Transit, Tri County Wheels, Inc.

[13] Transition Plan for the Southeastern Pennsylvania Transportation Authority, Statement of Policy, December 31, 1980.

- provide annual support for a paratransit service until at least one half of peak hour bus fleet was fully accessible ($45,000 per year).[14]

But the differences between the responses and costs required of a mid-sized bus system and a large multi-modal system like SEPTA were vast. SEPTA's Transition Plan contemplated that "key" stations on the system's commuter and subway lines would be made accessible, as would both the system's bus and rail fleets (excepting SEPTA's trolley car system). It also proposed that a citywide paratransit operation would be introduced.[15] The plan estimated total capital costs of $118 million (in 1980 dollars) over a 30 year period and projected annual operating expenditures to be $7.74 million, $4.3 million of which was to fund the paratransit service.

By contrast a 1980 Rail Retrofit Evaluation Study order by the Congress and commissioned by SEPTA projected the capital costs of modifying all rail stations over 50 years to be $519 million.[16]

Despite the range of cost estimates provided, the two studies make clear that the bulk of full accessibility's expense was attributable to retrofitting SEPTA's aging rail system. Particularly expensive modifications would have included building ramps to commuter rail station platforms, installing elevators in subway stations, regarding track, modifying station platforms to align them with rail car doors and, (at least for the purposes of cost calculation) building mechanical gap filling devices into new rail cars.

Programs

The promises contained in the three jurisdictions' Transition Plans were one thing, but what program change could be attributed to the full accessibility regulations?

It is believed the rules can be credited with spurring four different types of program changes—albeit at differing activity levels—across the three cities. These changes included:

(1) increased participation by the disabled in the transportation planning process;
(2) the acquisition of accessible fixed route vehicles;
(3) the conversion of several fixed facilities to wheelchair accessibility; and
(4) the creation of paratransit services for the handicapped.

One area where the regulations had a clear impact was involving the disabled in the extensive planning process the regulations dictated. Although elderly and handicapped advisory groups had existed for some time in a number of jurisdications (SEPTA, for example, established its elderly and handicapped advisory committee in 1974) the full accessibility regulations allowed those groups to participate in a much wider range of decisions than had formerly been the case. But while citizen participation efforts have continued in some form in Philadelphia and Erie, they have not been sustained in Harrisburg where CAT's citizen advisory board had not been convened since the rescission of federal full-accessibility regulations in 1981.

Second, in two of the communities surveyed—Philadelphia and Erie—some tentative steps were taken towards making fixed-route transportation systems accessible. In the wake of the Transbus debacle SEPTA proceeded to place orders for 298 (July, 1979) and 150 (November 1981) lift-equipped buses, renovate a handful of subway stations to make them accessible to wheelchairs, and ramp platforms at 20 of 174 commuter rail stations. Erie, after having its request to exempt its bus fleet from the accessibility requirement denied by DOT, proceeded to put lifts on approximately ten percent of its buses. And, while Harrisburg placed an order for lift-equipped buses, the rules were rescinded in time for CAT to cancel its order.

The Legacy of Full Accesibility

When the full accessibility regulations were withdrawn in 1981 each of the three jurisdictions took steps to retreat from the fixed route transit solutions proposed in their transition plans. In Philadelphia, SEPTA's board voted in early 1982 not to purchase any more lift-equipped buses and to use paratransit as the system's primary means of special efforts compliance. While SEPTA has continued to operate its fleet of 448 lift-equipped buses, in August, 1984, half of the lifts on those buses were not functioning. By the same token the withdrawal of federal rules led Harrisburg's CAT to cancel its order for lift-equipped buses and to eventually rely fully on a paratransit approach to carrying the disabled. The withdrawal of the rules also spurred Erie to terminate its plans to expand its limited lift-equipped services.

Does this mean then, that the 1979 rules were simply a political aberration which had no long term impact on these three sites? We do not think so, although one must hasten to acknowledge that identifying the long term effects of any policy is always a speculative endeavor. The primary impact of the regulations may have been the development of a broad institutional consensus that public transportation should be provided to the disabled at an appropriate level and quality. Whether this orientation would have emerged in the absence of full accessibility rules is uncertain. However, given the level of activity observed before the rules appeared imminent, and the dramatic character of service changes compelled by the mainstreaming mandate they embodied, it seems likely that the rules accelerated the institutional changes which have occurred. As one transit official stated, "Those rules just scared the hell out of us."

---

[14] Supra, note 10.

[15] Supra, note 11.

[16] DeLeuw Cather Assoc. et. al. Sections 321 Rail Retrofit Evaluation. Southeastern Pennsylvania Transportation Authority, January, 1980.

Paratransit Service in Philadelphia, Harrisburg and Erie

The three sites have, as mentioned above, moved unilaterally towards an emphasis on providing transportation to the disabled by means of paratransit service. Each has taken somewhat differing approaches, with varying levels of commitment and enjoyed differing levels of success. This section explores some of those differences, focusing on each jurisdiction's compliance with proposed federal cost and performance standards. The concluding section offers several observations on the unresolved character of the three efforts investigated.

Looking at the three sites one can make several general comments:

- none of the three would meet either the performance or minimum cost standards set out in proposed federal regulations;
- each provides the disabled with lower service levels than the exemplary sites chronicled in Everett's companion paper;
- each of the three programs has recently gone through a period of transition, suggesting that the current character of existing programs may be somewhat unstable.

Service Delivery Approches

SEPTA's paratransit program employs a "brokerage" format modelled on Pittsburgh's ACCESS system. The broker is responsible for hiring and managing the carriers, taking trip reservations, vehicle scheduling, reporting and coordination of agency transportation services. SEPTA's broker, Wheels Inc., is a private non-profit women's business enterprise with long experience in volunteer and social service agency transportation. The six carriers used in the program, drawn from for-profit and non-profit firms, are expected to supply all vehicles and drivers.

Harrisburg's paratransit efforts consist of three vans operated by a separately incorporated arm of the local transit agency, Susquehanna SET. All hiring, management, trip reservations and, vehicle scheduling and user certification is by staff of the transit agency. Drivers, however, are employees of the paratransit program not CAT. CAT's specialized transportation service, or Susquehanna SET, serves only what are referred to as "504 eligibles," that is, disabled riders not using public transportation services for social service-related travel. Service for all other speical needs populations—the non-disabled elderly, disabled persons living outside CAT's service area, elderly and disabled persons whose trips are related to social service agency programs and the like, has devolved to Dauphin County's Shared-Ride Demand Responsive Transportation Service, and, to a more limited extent, the Cumberland County Department of Transportation.

In Erie, responsibility for administering EMTA's paratransit operations has from the outset fallen to the Erie County Council on Elderly and Handicapped Transportation. The Council is made up of members of agencies which serve the elderly and handicapped, transportation carriers and members of the disabled community. While the Council makes general policy for the program, it has contracted all service delivery to the Erie Cab Company which takes reservations and schedules all rides.

Compliance with Proposed Federal Performance Standards

In December 1983 the U.S. Department of Transportation proposed regulations which would give local transit providers the option of (a) making 50 percent of both their peak and their non-peak hour fixed route bus fleets accessible to wheel chair users; or (b) establishing an adequate demand responsive system; or (c) providing a hybrid of the two. Should authorities adopt either of the latter two options the special service they provide must conform to six service criteria. The criteria were designed to ensure that specialized transportation systems provide service "comparable" to main line transportation in terms of fares charged, service area covered, hours of operation, the reasonableness of advance reservation requirements, and the restriction placed on travel. The criteria would also ban transit authorities from placing disabled riders on waiting lists.

Table I reveals that SEPTA paratransit falls short of comparability with the system's main line service in four areas: service area, hours of operation, fares, as well as federal standards for advance reservations.

To appreciate the real disparity between service provided by the paratransit and the SEPTA's main line service, though, there is need to probe somewhat deeper. Indeed, despite the results of the above assessment the SEPTA paratransit program has adopted rather liberal policies. No travel purpose restrictions are imposed, paratransit serves a 138 square mile area, its hours of operation are quite long and fares are roughly comparable to main line service ($1.00 vs. $.75).

Indeed the liberal character of SEPTA's program standards is in large measure responsible for inducing the high level of demand which makes access to the system so difficult. As no travel purpose restrictions are imposed, reservations are made on a first-come-first-served basis.

TABLE 1

Paratranist Service Profile & Comparability to Main Line Service Philadelphia, Harrisburg, Erie Paratransit Programs

Sites	*Fares*	*Area Served*	*Hours of Operation*	*Advance Reservation Requirements*	*Restrictions on Travel*	*Waiting Lists*
1. Philadelphia (SEPTA)	$1.00	Citywide transit district	6am-10pm weekdays 8am-12am Saturdays 9am-5pm Sundays Holidays	24 Hours	None	None
	(Slightly higher than regular service)	(Smaller than regular services)	(Shorter than regular service)	(In practive does not conform with 24 hour limit)	No restrictions imposed	J(Satisfies requirements)
2. Harrisburg (CAT)	.25	w/i ¼ mile of CAT bus service	8:30 am—4:30 pm Weekdys	24 Hours	Medical, Employment, Grocery Shopping	None
	(Lower)	(Same)	(Shorter)	(Meets 24 hour limit)	(Conflicts with ban on restrictions)	(Satisfies requirements)
3. Erie (EMTA)	.30	w/i ¼ mile EMTA bus route	24 Hour Service-cabs 6 am-6 pm-lift equipped vans	24 Hours	Medical, Employment, Essential Shopping	None
	(Lower)	(Same)	(Longer for taxi service. Shorter for van service. In practice does not conform to regulation.	(Does not meet 24 hour limit)	(Conflicts with ban on restrictions)	(Satisfies requirements)

As demand has been quite high, advance reservations must often be made a week ahead—a period of time which would apparently violate the advance reservation requirements set out in the proposed regulations.[17] Indeed program officials have estimated that they turn away as many potential riders as they serve. Moreover, the system's central phone line is busy so frequently that staff assume that an even higher proportion of would be riders are effectively denied service.

One partial explanation for these high demand levels is the problem of "offloading." The start of Paratransit's citywide program coincided with broad reductions in federal and other support for the region's social service agencies. As a result many of these agencies dropped or reduced the transportation services they formerly provided and rechanneled resources to other uses.

The principal rationing devices employed by Harrisburg's paratransit service—(see Table I) travel purpose restrictions, and reduced hours of operation—make it appear that CAT's program would be found deficient when measured by federal comparability regulations along at least two dimensions. Not only are service hours shorter than main line service, they do not extend through the full work day, making the paratransit program of limited value to disabled persons who are employed or employable. Moreover, service is not available on weekends.

In terms of purpose restrictions, Susquenana SET limits travel to medical trips, employment and grocery shopping. In addition SET promotional literature makes clear that the service cannot be used for trips which "replace any social service agency programs." Agency literature also indicates that service will only be provided to destinations within one quarter mile of a CAT bus route and to people living within a quarter mile of a bus route. No other jurisdiction surveyed in this study interpreted this minimum federal requirement so literally.

In addition to these rationing devices, which fall for the most part within the purview of the comparability regulations, SET has also imposed comparatively stringent eligibility and certification requirements. They include:

- a requirement that riders must be certified by a doctor, rather than a social service agency, and must recertify each year—regardless of their disability;
- a ban on service for individuals who are intermittently able to use main line service—a policy which can create substantial problems for persons whose ambulatory capacity fluctuates (those with severe arthritis, for example).

---

[17] See Section 27.77 (c). "Notice of Proposed Rulemaking: "Nondiscrimination on the Basis of Handicap in Programs Receiving Financial Assistance From the Department of Transportation" 48 F.R. 40604, September 8, 1983.

Looking at Table I one notices that, on paper, Erie's paratransit service is deficient in terms of two of six federal service criteria—the hours of its van service are not comparable to its main line service and it imposes restrictions on travel purpose. But again the system's "paper" performance does not fully capture the limitations it has imposed on the mobility of the disabled.

Over the past six years EMTA has dedicated $4400 per month to its paratransit operation. Despite the fact that the cost per-ride delivered by the Erie Cab Company has been low, a high sustained level of demand has meant that this $4400 monthly cap is usually reached by the middle to the end of the third week of every month. At that time, subsidized service simply stops. Moreover, in addition to this regular cessation of service, EMTA limits the disabled's mobility by applying tight purpose restrictions on travel.

The comparatively low service levels found in the three case study sites (evidenced by restrictions on travel purpose, long reservation requirements and uncertain access to service), were not observed in the paratransit programs of the three exemplary sites described in Everett's paper. There, a combination of higher resource commitments, more stable program development, lower-cost service and, in one case, the deployment of alternative rationing devices (i.e., Milwaukee's use of comparatively stringent eligibility standards and high fares) supported higher relative service levels. These higher service levels in turn appear to permit the cities in question—Milwaukee, Lancaster and Pittsburgh—to come closer to satisfying federal performance standards.

Compliance with Proposed Minimum Cost Criteria

As Table 2 indicates, each of the three jurisdictions would be required to substantially increase current expenditures on its paratransit service in order to meet either of the two minimum cost criteria formulas set out in the regulations. One formula would require that local transit agencies spend the equivalent of 7.1 percent of their average annual federal assistance over three years for special services; the other would require an expenditure of 3 percent of the agency's average annual operating budget for 3 years. Dramatic cost increases for SEPTA are explained by the fact that FY84 expenditures for SEPTA paratransit (along with other allowable expenses associated with providing fixed route transit service for the disabled) amounted to less than one percent of SEPTA's total operating budget of $425 million.

TABLE 2

Percent Increased Expenditure to Comply with Proposed Federal Regulations

		Special Services	
Percent Increase	*Philadelphia*[b]	*Harrisburg*[c]	*Erie*[d]
7.1 percent average federal assistance[a]	+ 289	+ 54	+ 227
3 percent operating budget[a]	+ 380	+ 229	+ 69

a Calculated for FY 1982, 1983, and 1984.

b ***SOURCE***: SEPTA Comments on Notice of Proposed rulemaking Entitled "Nondiscrimination on the The Basis of Handicap In Programs Receiving Financial Assistance from The Department of Transportation. "December 1, 1983.

c ***SOURCE***: Captiol Area Transit Authority.

d ***SOURCE***: Erie Metropolitan Transit Authority.

Continued Change

Finally it is observed that the fundamental character of programs administered in the case study sites has recently been, or is now, in flux. That finding contrasts sharply with the relative stability of programs administered in the "exemplary" sites detailed in the Everett paper.

To illustrate, Harrisburg's original, short-lived attempt to provide paratransit service collapsed and was discontinued in 1981 when an independent regional carrier, Wheels, Inc., went bankrupt. Service to disabled persons covered under Section 504 was later revived and brought under the aegis of the Capitol Area Transit Company in early 1982. The reconstituted program was, for all intents and purposes, a new effort. Shortly before this paper was completed CAT announced that it was closing down Susquehanna SET and was turning program operations over to paratransit programs in place in Dauphin and Cumberland Counties.

As this is written, both Philadelphia and Erie's paratransit programs serving the disabled are in the process of being consolidated into larger special efforts transportation networks intended to serve a broad cross section of special needs populations (the poor, the elderly, etc.). In both cases consolidation will result in the creation of a substantially expanded paratransit program which will administer centralized, computerized operations.

This movement to consolidation has been particularly widespread in Pennsylvania—due in large part to the availability of funds under the state's lottery program. Under the program (Section 203 of Act 101 of 1980) a portion of the proceeds of the highly successful state lottery is distributed to public and private transit operators to provide reduced fare transportation services to the elderly—including, of course, the disabled elderly. In FY 1984, for example, SEPTA Paratransit was reimbursed $585,000 for services provided to the disabled elderly.

The funds affect paratransit system operations in a number of ways. First, and most importantly, they reimburse local authorities for 90 percent of the cost of transporting elderly disabled riders. As a substantial percentage of the rides provided by each system are to persons over 65 (50-60 percent of the rides provided by Erie's paratransit program are to the disabled persons over 65 years old) the program contributes substantial supplementary revenue often permitting some expansion of the existing program. Second, conditions on the receipt of lottery funds effectively expand the population eligible for some form of subsidized demand-responsive travel to include the able-bodied as well as the disabled elderly.

One such consolidation is imminent in Philadelphia where SEPTA Paratransit is considering taking over administrative responsibility for Philadelphia County's Medical Assistance Program, which provides the indigent with transportation to medical services. If such a merger were to take place, the total number of rides for which SEPTA Paratransit would be responsible would increase from approximately 20,000 per month to 110,000. Given the capacity and provider-incentive problems of the current operation, this five fold increase represents a tremendous potential for further changes in user access and service quality. In addition to the system-wide changes which consolidation would introduce, SEPTA is also considering taking over and internalizing its broker's functions.

In Erie a county-wide consolidation of special services transportation is currently underway. The consolidation would also create a centralized, computerized scheduling and routing operation and would fold in a wide range of special efforts transportation programs.

Proponents of consolidation within both cities argue that it offers economies of scale in program administration. They also contend that such consolidations offer system administrators greater leverage over providers, putting them in a better position to comand lower prices and high productivity levels.

However, critics of such large scale centralized systems believe they often generate program diseconomies and that they increase productivity by reducing service quality. In addition, these critics contend that computerization takes more time and money than expected and its effectiveness has yet to be conclusively demonstrated. They argue that program funds devoted to administrative costs could be better spent transporting persons rather than coordinating activities. Other approaches to consolidation—such as those which emphasize coordinating services and pooling different funding sources—are less expensive but still allow provider competition and user choice.

Finally, such consolidations raise the issue of segregating the disabled in transportation systems which resemble "public modes of transportation less and less, and resemble social service program more and more." Carried to its logical extreme, this development could thwart the basic purpose of Section 504.

Conclusion

Federal regulations were clearly responsible for spurring efforts to provide public transportation to the disabled within each of the three case study communities. In particular, federal "full accessibility" regulations were instrumental in forcing institutional adaptations which led to the establishment and operation of transportation programs for the disabled.

Similarly the withdrawal of those full accessibility regulations in 1981 has led to uniform results across the three sites. In each case efforts to make fixed route transport modes accessible were de-emphasized in lieu of paratransit or demand responsive approaches.

According to this analysis, none of the three jurisdictions would meet either federal performance or cost standards set out in regulations promulgated in September 1983. Of particular interest and concern is the fact that each falls far short in providing travel to all eligible populations on demand or within reasonable waiting periods. Two of the three impose strict travel purpose restrictions (Erie and Harrisburg); one system has for years experienced periodic, system-wide shut downs (Erie) and one system has grown so overburdened by demand that unreasonably long advance reservation times have developed, making system access difficult and uncertain (Philadelphia). In addition, Philadelphia, Erie and Harrisburg would all be compelled to substantially increase their expenditures on paratransit if they were to comply with the minimum expenditures set out in the proposed federal regulations.

Where higher service levels were observed during the study (as documented in Carol Everett's paper), they may be partially explained by the fact that officials there committed themselves comparatively early to their current service approach. As a result, their programs have evolved in a stable, steady manner despite changes in federal regulations and have, for the most part, developed the support of the transit agency and of the disabled community over time.

By contrast, paratransit efforts in the three sites examined here were either in the process of changing their fundamental character or had recently undergone major changes at the time observed.

Michael Fix, Senior Research Associate, Urban Institute, 2000 M St., N.W., Washington, D.C. 20037.

A NON-COMPENSATORY APPROACH TO THE TRAVEL BEHAVIOR OF THE ELDERLY AND HANDICAPPED

Howard L. Gauthier and Bruno P. Parolin

Introduction

The study of choice behavior in urban areas has been the subject of investigation in the recent transportation literature. The process of travel mode choice behavior has been a specific focus of attention. Two important findings have emerged on individual urban travel behavior. First, many axioms of travel behavior models are unrealistic. The decision process is increasingly viewed as non-utility maximizing and non-compensatory (Burnett, 1978). Second, structural, societal, and institutional constraints affect travel mode behavior by (i) limiting the choice set, (ii) molding the formation of attitudes and preferences, (iii) inducing choices not in conformity with preferences, and (iv) preventing choice actualization (Burnett & Hanson, 1979; Desbarates, 1983).

Non-compensatory travel behavior has been studied mainly for an urban automobile oriented population (Timmermans, 1983). One sub-group with severe travel constraints which has received limited attention is the urban elderly and physically handicapped (Parolin, 1982; Gauthier and Parolin, 1983). While this group faces many travel restrictions, physical disability has been studied regarding (i) travel mode perceptual and preference formation, (ii) travel choices not in conformity with preferences, and (iii) travel choice decision strategies.

This paper reports on research in which non-compensator travel behavior is linked to physical barrier constraints experienced by the urban elderly and handicapped. The objective is the development and estimation of travel demand models for the elderly and handicapped which incorporate the effects of physical barrier constraints, travel mode choice decision strategies and processes.

The purpose of these objectives is to understand the components of travel demand by the elderly and handicapped in the context of reduced mobility, reduced accessibility, and limited spatial interaction. Knowledge of the interactions between physical barrier constraints, choice rules, and choice processes is useful information to policy makers and transit managers alike. It should enable them to identify what is required for a responsive and equitable transportation system to serve the elderly and handicapped. In addition, it should enable more accurate forecasts of the demand for travel services.

Background

Some consideration of the effects of physical barrier constraints on travel mode attribute importance and preference is represented in the research of Falcocchio et al (1975) and Miller (1976). A behavioral and attitudinal approach to the effects of physical barrier constraints on travel mode choice behavior is the research of Gauthier (1980) and Parolin (1982). Several of their findings are relevant to this research. First, market segments were identified for a sample population. For each segment there was identified a distinctive set of travel mode cognitive dimensions. The attribute components of these dimensions were shown to vary across market segments and to reflect the effects of physical barrier constraints. Second, it was found that physical barrier constraints were influential in the formation of travel mode cognitive perceptions, travel mode preferences and in inducing travel choice not in conformity with preferences.

A major finding was the presence of non-compensatory behavior and of decision simplification in travel mode choice. Among the market segments, only a few attribute screening criteria were important in the discrimination between travel modes. Not all attributes were evaluated in the choice process. The important attributes all reflected the need to overcome physical barriers. Those which could satisfy the screening criteria were selected while others were not.

These findings suggest that travel demand models for the elderly and handicapped must include non-compensatory and non-utility maximizing choice behavior if actual choice is to be replicated. Demand models also should include market segmentation to include the effects of physical barrier constraints on travel mode choice. Although several useful studies have attempted to forecast demand for travel, they lack the conceptual framework which incorporates choice behavior by the elderly and handicapped (Knighton and Hartgen, 1977; Lago and Burkhardt, 1980). Disaggregate travel demand models have been used widely in recent years (Recker and Golob, 1976; Recker and Steven, 1977; Koppelman and Pas, 1980). The random utility multi-nomial logit model (MNL) is most often used to estimate modal split for different urban population groups. The assumptions about travel behavior in the MNL model are well known, and

Burnett (1980) provides a critical review of the axioms of current choice models.

One set of assumptions in the MNL model requires the individual to integrate a large amount of information. This does not correspond to the evidence from psychology that individuals maintain a discrminal function of limited dimensionality (Edwards, 1957). McQuire (1973) has observed that evaluation on the basis of a large set of factors is difficult, given limited human information processing abilities.

Further criticism of compensatory and utility maximizin behavior lend support to the objectives of this research. For example, Wright (1975) has indicated that the evaluation or integration of multi-attribute options occurs through simplifying procedures as opposed to optimizing procedures. As simplifiers, consumers display limited trade-off (compensatory) behavior and opt for non-compensatory strategies. Einhorn (1970) suggests two non compensatory strategies in information integration. In a disjunctive model, the consumer displays a preference for any mode possessing more than a minimum level of salient travel mode attribute. In a conjunctive model, any travel mode alternative not possessing a certain minimum level of a salient attribute is rejected.

Another non-compensatory and simplistic selection process is lexicographic choice (Tversky, 1972). It assumes that the consumer selects the single most important attribute on which to compare choice set alternatives. From the three choice strategies mentioned, it is clear that individuals may simplify the choice process by reducing cognitive overload. These alternate choice strategies have been shown to be important in travel choice decisions (Foerster, 1979; Recker and Golob, 1979).

Research Methodology

A questionnaire survey sponsored by the Central Ohio Transit Authority (COTA) was administered to 985 elderly and physically handicapped individuals in the Columbus urban area. Information supplied by 309 respondents form the basis for this analysis.

The questionnaire includes six different travel modes available in the Columbus urban area. Included were those modes which cater specifically to the travel needs of the physically handicapped. The modes are: automobile, auto passenger, taxi (personal payment), Project Mainstream taxi service, fixed route bus (COTA), and Project Mainstream van service. Project Mainstream taxi service is utilized by qualified elderly and handicapped individuals the cost is subsidized by COTA. Project Mainstream, a special van service for the elderly and handicapped, has been operational since 1978. Operated by COTA, it requires twenty-four hour notification provides curb-to-curb service, is wheelchair lift equipped, and offers subscription service.

Physical barrier constraints experienced by the sample were used as a basis for market segmentation. Twelve types of constraints are used in the market segmentation approach (Table 1). Each disability affects individual capabilities to perform physical functions. Of necessity, each reduction in physical restriction will not only limit individual physical activity in travel, but limit the spatial extent of travel itself. This research treats physical constraints both as a barrier to movement and a variable affecting market segment evaluations of travel mode attributes and choice decision strategies.

TABLE 1

Physical Barrier Constraints of the Sample Population

	Percentage
1. No serious restrictions affecting use of the transportation system	25.50
2. Need some special aid such as a wheelchair	16.54
3. No serious problems in standing or walking	8.20
4. Difficulty in standing	57.89
5. Difficulty in walking to curb or bus stop	59.39
6. Severe difficulty in climbing stairs (need assistance)	36.80
7. Minor difficulty in climbing stairs	29.32
8. Serious visual impairment	24.90
9. Problems with being in a crowd	18.79
10. Serious hearing impairment	9.70
11. Must stay in bed all or most of the time	3.00
12. Must stay in house all or most of the time	17.29

Non-Compensatory Choice Model

For a non-compensatory analysis, a modified random utility MNL model is utilized (Chou, 1983). The model first calculates estimated travel mode preference rank order (P_i) by comparing relative preferences rank orders (RP_i) to a selected base mode z,

$$P_i = \frac{RP_i}{RP_i + RP_z}$$

Second, the model relates preference, P, to satisfaction value, V, through a binary MNL model,

$$P_i = \frac{1}{1 + \exp \sum_{i=1}^{n} B_j (V_{zj} - V_{ij})}$$

where B_j = the parameter of relative weight of the difference in attribute satisfaction; V_{ij} = satisfaction level of mode i with respect to attribute j; $(V_{zj} - V_{ij})$ = the difference in attribute satisfaction. Parameter values (Bj) in this model are not estimated using MLE methods but instead are estimated using Ordinary Least Squares (OLS) methods (Domencich and McFadden, 1975). The resulting beta values, or estimated attribute importance indices, are then used as input to the next modeling stage -the evaluation of non-compensatory strategies.

(i) Lexicographic Choice—in the modified MNL model a travel mode is selected by this strategy only if the following two conditions are met:

$$V_{(ij)} = \max\ (i=1,\ m)\ V_{(i,j)}$$

$$B_{(j)} = \max\ (j=1,n)\ B_{(j)}$$

(ii) Conjunctive Choice—a travel mode is selected by this strategy in the model such that,

$$V\ (i,j) = \min\ (i=1,\ m;\ j=1,\ n)\ V\ (i,j)$$

(iii) Lexicon Choice Strategy—the lexicon model was developed by Chou (1983) to eliminate the problems associated with the conjunctive and lexicographic choice strategies. The Lexicon model requires that a mode be eliminated from the alternatives if the following conditions are met:

$$B_j\ V_{ij} - V_{zj} = \mathrm{Max}\ (j=1,\ n)\ (B_j\ V_{ij} - V_{zj})$$

$$V_{ij} = \mathrm{Min}\ (i=1,\ m)\ (V_{ij})$$

This model sequentially eliminates alternatives according to the most important difference in satisfaction level. The differences in satisfaction are weighted by attribute importance.

Research Results

Table 2 lists the socio-economic and travel related characteristics of the elderly and handicapped sample population. The profile is one of a population which is predominantly female, likely to be unemployed or retired, and residing in private dwellings or apartments. Travel characteristics indicate the auto passenger as the primary mode of private transportation (48.1 percent) among the sample. Project Mainstream services are the primary modes of public transportation (81.2 percent) among the sample. Trip frequency statistics indicate relatively infrequent travel by the sample population. Most make one or two trips per week to visit a doctor, purchase food, or attend senior citizen functions. Medical trips are the most important (67.6 percent).

Travel preferences are overwhelmingly for public modes (Project Mainstream services) which are demand responsive, provide curb-to-curb service, and are low cost. The auto-passenger, which is the most frequently used mode, is the third most preferred travel mode. This indicates that for many of the sample population their actual choice is not in conformity with their preferences.

TABLE 2

Socio-Economic and Travel Related Characteristics of Sample Population

	Percentage
Age:	
18-25	9.2
26-35	9.0
36-45	9.0
46-55	12.7
56-65	26.3
Over 65	33.8
Sex:	
Male	35.4
Female	64.6
Dwelling:	
House	45.2
Apartment	39.8
Nursing Home	1.6
Retirement Center	9.7
Motel/other	3.7
Employment:	
Unemployed full-time	8.2
Unemployed	22.5
Retired	45.3
Employed part-time	3.7
Homemaker	20.3
*Travel Modes Frequently Used:	
Auto Passenger	48.1
Auto Driver	7.5
Taxi (Personal Payment)	17.2
COTA (Regular Bus)	23.3
Project Mainstream Van Service	40.6
Project Mainstream Taxi Service	40.6
Trips Per Week on Most Frequently Used Mode:	
0-1	28.3
2-3	29.8
4-5	9.7
6-7	4.5
8-9	4.5
10 or more	12.0
None	11.2
*Trip Types:	
Work	16.5
Education	12.0
Medical	67.6
Shopping	39.0
Personal Busines	27.0
Personal Pleasure	28.5
*Travel Mode Preferences:	
Auto Passenger	30.8
Auto Driver	13.5
Taxi (Personal Payment)	10.5
COTA (Regular Bus)	24.8
Project Mainstream Van Service	45.1
Project Mainstream Taxi Service	49.6

* Will not sum to 100 percent.

To identify market segments, Ward (1964) HGROUP clustering algorithm is used. The criteria for determining the number of market segments are the types of physical constraints possessed by the sample population. Table 3 presents selected characteristics of the three internally homogeneous market segments which are defined as:

Group 1: No Serious Restrictions
Group 2: Minor Restrictions
Group 3: Wheelchiar Users.

Of note is the similarity of each segment's situational profile to that of the larger sample. The three market segments are also representative of the diversity in travel needs, physical constraints, and orientation to travel modes. This diversity indicates that attributes of importance to respective market segments will vary. When these attributes are used to simulate travel demand, it is expected that the choice strategies and goodness-of-fit statistics will vary. In addition, the effects of physical constraints on choice strategies and travel behavior are expected to be defined through market segmentation.

Non-Compensatory MNL Model Results

Table 4 presents results from the non-compensatory demand models. Several conculsions are evident. As expected, the PCE statistics indicate that non-compensatory strategies clearly outperform a compensatory strategy in mode choice behavior: the non-compensatory models predict mode choice more accurately than the compensatory model. Also, the convenience and assistance attribute are the most important criteria for the sample population.

An additional finding is that the lexicographic decision strategy model is the most accurate predicter of mode choice. It is important then to consider the relationships between a lexicographic decision strategy, physical barrier constraints, and the attributes of importance. The importance of the convenience attribute is related to, (i) the need to reduce the burden of travel, and (ii) the importance of easy access to travel modes. This is significant given the debate over mobility versus accessiblity for the elderly and handicapped. Clearly, the sample population has opted for access and convenience. Their physical constraints demand an opportunity to move form residence to a travel mode with minimal effort. Of equal importance is the need for assistance in getting on and off a vehicle.

Without easy access to a mode and some form of assistance, the possibilities for satisfying travel needs and requirements are limited. For these reasons, a lexicographic choice strategy predominates among the sample population. Two travel modes, the auto-passenger and Project Mainstream taxi service, meet the limited screening criteria of the sample population very successfully.

TABLE 3

Characteristics of Identified Market Segments

	Percentage		
	1 *N-37*	*2* *N-72*	*3* *N-24*
Age:			
18-25	8.1	4.1	20.8
26-35	13.5	2.7	20.8
36-45	5.4	11.1	8.4
46-55	16.2	12.6	8.4
56-65	24.3	27.8	25.0
Over 65	32.5	41.7	16.6
Sex:			
Male	48.6	25.0	45.8
Female	51.4	75.0	54.2
Dwelling:			
House	48.6	45.8	37.5
Apartment	37.8	34.8	58.3
Nursing Home	5.5	—	—
Retirement Center	2.7	15.3	4.2
Motel/other	5.4	4.1	—
Employment:			
Employed Full-Time	10.8	6.9	8.3
Employed Part-Time	13.5	—	—
Unemployed	18.9	23.7	29.1
Retired	56.8	69.4	62.6
*Travel Modes Frequently Used:			
Auto Passenger	45.9	45.8	58.3
Auto Driver	10.8	4.1	12.5
Taxi (Personal Payment)	27.0	13.8	12.5
COTA (Regular Bus)	40.5	20.8	4.1
Project Mainstream Van Service	40.4	38.8	45.8
Project Mainstream Taxi Service	37.8	45.9	33.3
Trips Per Week on Most Frequently Used Mode:			
0-1	18.9	30.5	25.0
2-3	27.0	29.1	25.0
4-5	16.2	8.3	4.2
6-7	8.1	7.2	4.2
8-9	5.4	2.7	8.3
10 or more	13.5	11.1	20.8
None	10.9	11.1	12.5
*Trip Types:			
Work	27.0	11.1	16.6
Education	16.2	5.5	25.0
Medical	56.7	75.0	62.5
Shopping	45.9	33.3	45.8
Personal Business	37.8	20.8	29.1
Personal Pleasure	37.8	16.6	50.0

* Will not sum to 100 percent

This suggests that in an ideal transportation system for the elderly and handicapped, the minimum requirements are high levels of convenienc and assistance.

Table 4 also shows results from a series of non compensatory MNL models for three market segments.

No Serious Restrictions Segment: For this subsample the conjunctive choice model indicates the highest percen-

TABLE 4

Non-Compensatory MNL Model Results

Sample Population

		Non-Compensatory		
	Compensatory	Lexicographic	Conjunctive	Lexicon
PCE (%)	0%	46%	25%	29%

Attributes: 1. Convenience
2. Assistance

No Serious Restrictions Segment

		Non-Compensatory		
	Compensatory	Lexicographic	Conjunctive	Lexicon
PCE (%)	10.8%	0%	42%	11%

Attributes: 1. Suitability
2. Assistance
3. Friendly & Courteous Drivers
4. Sensitivity & Understanding

Minor Restrictions Segment

		Non-Compensatory		
	Compensatory	Lexicographic	Conjunctive	Lexicon
PCE (%)	1.3%	40%	40%	40%

Attributes: 1. Cost
2. Convenience
3. Comfort
4. Privacy
5. Personal Nature

Wheelchair Users Segment

		Non-Compensatory		
	Compensatory	Lexicographic	Conjunctive	Lexicon
PCE (%)	29.1%	28%	75%	38%

Attributes: 1. Convenience
2. Assistance

tage of correct estimations. For a market segment which possesses no serious restrictions in using travel service, a conjunctive choice strategy is conceptually sound because individuals evaluate more attributes and establish a minimal threshold level. The relative absence of physical constraints also allows a perceptual structure which is more concerned with effort in travel. For this reason, travel burden is viewed as requiring, (i) a friendly and courteous driver, (ii) a suitable travel mode, and (iii) the psychological satisfaction that assistance is available if required.

Minor Restrictions Segments: For this market segment, all three non-compensatory choice strategies perform equally well in the simulation of travel choice.

The importance of cost, convenience, comfort, privacy, and personalized service are similar to those of a mobile population. With only minor restrictions, this segment is able to utilize modes providing high levels of mobility. There is little need to be as concerned with overcoming physical constraints. Non-compensatory models for this segment suggest an ideal transportatio system would be composed of attributes associated with a high quality of service. Existing travel services are available to meet the needs of this segment. Project Mainstream services and the auto-passenger travel modes are demand responsive services which they percive as providing such service.

Wheelchair Users Segment: For this group the conjunctive MNL model shows the highest percentage of correct estimations. The attributes of comfort and personal assistance are important criteria by which travel modes are evaluated. The concern with comfort and assistance is an attempt to minimize both physical and travel constraints in the process of travel. Travel modes perceived to possess these important attributes are Project Mainstream Van Service and the auto-passenger mode.

Interestingly, the wheelchair users do not appear to be as concerned with access, or mobility, in travel as other groups. This may be due to the fact most wheelchair users have several alternatives in their choice set. In most cases, access to the vehicle is overcome through a wheel chair lift equipped feature. The predominant concern among the wheelchair users is with quality, effort, and comfort in travel

The attribute composition of the models serves to highlight the sample population's perception of an ideal transportation system. In general, there is a strong preference for demand responsive systems that offer a high level of service. Comfort, convenience, assistance, privacy, and personalized service, etc., are attributes of importance. For several market segments these attributes represent strong concerns for, (i) access to travel modes, and (ii) minimal effort in travel.

Summary and Policy Implications

Several of the conclusions from this research have policy implications for the elderly and handicapped. The strong characteristics of non-compensatory travel mode choice behavior by the sample population lends support to recent evaluations of the postulates underlying travel mode choice behavior. The sample population are simplifiers in the decision process and non-utility maximizers in the final choice process. The important implication is that travel demand analysis (modeling) for the elderly and handicapped should include non-compensatory behavior. In forecasting demand for travel services designed for the elderly and handicapped, non-compensatory MNL models are the most accurate.

Additional justification for non-compensatory analysis is evident in other conclusions. Physical barrier constraints, as reflected in the market segments, define the attributes of perceived importance in travel mode choice. Thus, physical constraints permeate the entire process of travel mode choice behavior. Developing non-compensatory models for market segment allows planners and policy makers to, (i) disaggregate a heterogeneous group into segments based upon their ability to use travel facilities, (ii) target travel service improvements to particular segments, or to a larger group, and (iii) evaluate the perceived attributes of importance in forecasting demand.

It is also evident that the elderly and handicapped sample population perceive access to travel services as an important consideration in mode choice decision making. This concern is a function of their physical barrier constraints. A preoccupation with mobility is not apparent among the sample. Thus access to travel services is one important area that should be examined by policy makers and planners. The attributes of importance for the sample, in terms of accessibility, are personal assistance, sensitivity and understanding, friendly and courteous drivers, and travel mode comfort.

The prevalence of accessibility concerns among the elderly and handicapped sample brings into question what is an 'ideal' transportation system. Although accessibility concerns predominate, the elderly and handicapped do not perceive the need for a radically different transportation system to meet their needs and requirements. For the travel services which provide mobility for the elderly and handicapped, the findings show the sample to be satisfied with current demand responsive services. High preference and mode usage statistics for Project Mainstream van and taxi services, COTA regular bus, and the auto passenger are indicative of 'ideal' travel services

Transit planning agencies should realize that the elderly and handicapped population which they serve is a heterogeneous one. There exists much variation in their physical barrier constraints, travel needs and travel requirements. Only when this heterogeneity is clearly defined can transit agencies implement appropriate policies to reduce the burden of travel, and improve overall accessibility.

References

Burnett, P., "Spatial Constraints Oriented Modeling as an Alternative Approach to Movement, Microeconomic Theory, and Urban Policy." Urban Geography, Vol. 1, No. 1, (1980), pp. 53-67.

Burnett, P. and S. Hanson, "A Rationale for An Alternative Approach to Movement as a Complex Human Behavior". Transportation Research Record No. 723, 1979.

Chou, Y., The Compensatory and non-Compensatory Attitudinal Model for Travel Mode Choice Behavior, unpublished Ph.D. dissertation, Department of Geography, The Ohio State University, 1983.

Desbarates, J., "Spatial Choice and Constraints on Behavior," Annals, Association of American Geographers, Vol. 73, No. 3, 1983, pp. 340-357.

Domencich, T. and D. McFadden, Urban Travel Demand: A Behavioral Analysis, Amsterdam: North Holland Publishing, 1975.

Edwards, A. L., Techniques of Attitude Scale Construction. New York: Appleton-Century-Croft, 1957.

Einhorn, H. J., "The Use of Nonlinear, Non-Compensatory Models in Decision Making." Psychological Bulletin, Vol. 73 (1970), pp. 221-230.

Falcocchio, J., et al., "Travel Patterns and Mobility Needs of the Physically Handicapped." Transportation Research Record, No. 618 (1976), pp. 13-16.

Foerster, J. F., "Mode Choice Decision Process Models: A Comparison of Compensatory and Non-Compensatory Structures." Transportation Research, vol. 13A (1979), pp. 17-28.

Gauthier, H. L., Transportation Perceptions of a Handicapped Population in Central Ohio, Summary Report Prepared for the Central Ohio Transit Authority, Columbus, Ohio, 1980.

Gauthier, H. L. and B. P. Parolin, Travel Demand Analysis for the Elderly and Handicapped: A Case Study of Central Ohio, Report to the Urban Affairs Committee, The Ohio State University, September, 1983.

Knighton, R. D. and D. T. Hartgen, "Incorporation Barrier Effects in Elderly and Handicapped Non-Work Transit Demand Forecasts," Preliminary Research Report 116, N.Y.S.D.O.T., Albany, New York, 1977.

Koppelman, F. S. and E. I. Pas, "Travel Choice Behavior: Models of Perceptions, Feelings, Preference, and Choice." Transportation Research Record, No. 765 (1980), pp. 26-33.

Lago, A. M. and J. Burkhardt, "Predictive Models of the Demand for Public Transportation Services Among the Elderly." Transportation Research Record, No. 784, 1980.

McGuire, W. J., "The Yin and Yang of Progress in Social Psychology: Seven Koan." Journal of Personality and Social Psychology, Vol. 26 (1973), pp. 446-456.

Miller, J. A., Identification and Definition of the Mobility Requirements of the Elderly and Handicapped, unpublished Ph.D. dissertation, Northwestern University, 1975.

Parolin, B. P., Physical Barrier Constraints and the Travel Mode Choice Behavior of the Elderly and Handicapped, unpublished Ph.D. dissertation, Department of Geography, The Ohio State University, 1982.

Recker, W. W. and T. F. Golob, "An Attitudinal Modal Choice Mode." Transportation Research, Vol. 10 91976), pp. 299-310.

Recker, W. E. and R. F. Stevens, "An Attitudinal Travel Demand Model for Non-Work Trips of Homogeneously Constrained Segments of a Population." Transportation Research, Vol. 11 (1977), pp. 167-176.

Timmermans, H., "Non-Compensatory Decision Rules and Consumer Spatial Choice Behavior: A Test of Predictive Ability." The Professional Geographer, Vol. 35, No. 4, 1983, pp. 449-455.

Tversky, A., "Elimination by Aspects: A Theory of Choice." Psychological Review, Vol. 79, 1972, pp. 281-299.

Ward, J. H., "Hierarchical Grouping to Optimize an Objective Function," Journal of the American Statistical Association, Vol. 58 (1963), pp. 236-244.

Wright, P., "Consumer Choice Strategies: Simplifying vs. Optimizing," Journal of Marketing Research, Vol. 12 (1975), pp. 60-67.

Howard L. Gauthier, Professor, Department of Geography, Ohio State University, Columbus, Ohio 43210.

Bruno Parolin, Director of Modelling, Ministry of Transport, Melbourne, Australia.

MONITORING THE TRIALS OF A PROTOTYPE TAXI ACCESSIBLE TO DISABLED PEOPLE

M.S. Hall, D.T. Silcock, J. Haigh, and D. Hofmann

Introduction

Background to the Project

In recent years there has been an increasing awareness of transport problems faced by disabled people in the United Kingdom (UK). As a consequence, efforts have been made by both central and local governments and by transport operators to make transport systems more accessible to people with a wide range of disabilities. The Department of Transport (DOT) initiated a number of projects along these lines during 1981, The International Year of the Disabled. One of these involved participation with Carbodies Limited in the design and development of a new taxi-cab.

Carbodies manufacture the FX4 black London cab and were, at the time, designing a replacement model, code-named CR6. During discussions with the DOT and its Transport and Road Research Laboratory (TRRL) the design of the CR6 was modified to improve its capability to accommodate disabled passengers whilst seated in their wheelchairs. The DOT purchased two "prototype" vehicles from Carbodies with the intention that they be subject to extensive field trials.

The term prototype is used here to describe the two vehicles subject to trial although it must be stressed that they were not engineering prototypes in the conventional sense. They are more properly described as factory mock-ups which were converted into running vehicles because the DOT was keen to obtain early experience in transporting disabled people in taxis, under a variety of operational modes. These two vehicles preceeded those constructed to test engineering aspects, such as suspension design or choice of engine, and gave only a preliminary idea of the engineering package.

The Transport Operations Research Group (TORG) and the Design Unit of the University of Newcastle upon Tyne were commissioned by TRRL to monitor the field trials of the vehicles and to evaluate the design of the prototypes, with particular reference to their use by disabled people. TRRL placed four operating contracts for the two vehicles during the period May 1982 to mid 1984. This paper presents some of the results of those trial operations.

The Operating Contracts

The four placements and the periods over which data were collected and reported here are:

for Prototype 1—Community Transport, Newcastle upon Tyne: 11 May 1982-30 May 1983; and Potteries Motor Traction, Stoke on Trent: 20 July 1983-31 December 1983; and

for Prototype 2—Boulton's Peterborough Taxis, Peterborough: 26 July 1982-31 May 1983; and Edinburgh Cripple Aid Society/Radiocabs, Edinburgh: 29 September 1983-31 December 1983.

The four operating contracts are referred to as the Newcastle, Peterborough, Stoke and Edinburgh placements, respectively. There were only small physical differences between the two prototype vehicles which can be discounted for the purpose of this paper.

The first operator is a registered charity, providing transport to disadvantaged groups and the CR6 was used in Newcastle almost wholly to transport disabled people. Boulton's Taxis is a small commercial taxi operation whilst Potteries Motor Traction (PMT) is a National Bus Company subsidiary which uses a small number of taxi-cabs to provide a Flexibus service. The Edinburgh placement is to a charity, Edinburgh Cripple Aid Society (ECAS), providing transport facilities to certain groups of people, with the vehicle being operated by a commercial taxi operator.

The operators were to operate the vehicle, provide qualified drivers, and be responsible for financial management. Records were to be kept of the use made of the vehicle, the costs of using it and the revenue earned. Although ownership of the vehicle remained with the Department of Transport, the vehicle was provided to be used by the operator "as though it was owned by them." This was to "include use wherever possible by people with a wide range of disabilities." It was intended that the operators use the vehicles according to their respective commercial criteria.

Aims and Objectives

There were two main aims of the monitoring:

a. to evaluate the design of the prototype CR6 for use by disabled people; and

b. to examine the operational performance of the prototype vehicles.

A subsidiary aim was to produce guidelines for the designers of other vehicles intended for use by disabled people.

It is important to remember that the basic purpose of the vehicle is as a taxi to transport able-bodied persons.

The field trials summarised here, and the aspects highlighted in the report, represent conditions far from typical of those which the production vehicles generally will face. In normal taxi-cab operation, disabled passengers will be few and far between.

Specific objectives for the research programme were defined as:

1. to evaluate the design of the CR6 for use by disabled people;
2. to review the practical problems encountered by disabled people in using small vehicles;
3. to produce guidelines for the design of small vehicles which are intended for use by disabled persons;
4. to evaluate the operational performance of the prototypes, with particular reference to costs and patterns of use;
5. to determine the travel patterns of those who make use of the prototype vehicles; and
6. to report on the findings.

These will be reported in full in due course. This paper is mainly concerned with objectives 4 and 5.

Methods and Data Collecton

Framework

Data collection had two major elements, field observations of the performance of the prototypes under real operating conditions and controlled experiments where a range of conditions were simulated and the response of volunteer users were noted. The first element provides the main source of information for the operational evaluation, the second element contributes to evaluating the design for use by disabled persons.

Table 1 illustrates the various sources of information which were established and which provide the data for this paper.

Problems Encountered

At an early stage in the project it became apparent that no national data base is available which describes the sizes of wheelchairs in current use in the UK. Further, there was no means of testing the hypothesis that wheelchairs used out of doors differed significantly in size from those used only indoors. Knowledge of the statistical distribu-

TABLE 1

Framework of data collection

Type of data

(relevant objective numbers given in brackets)

Source of Information	*Ergonomic (1,2,3)*	*Travel patterns and attitudes of users (1,2,3,4,5)*	*Operating Usage (2,3,5)*	*Performance costs (4)*	*Attitudes of operators (1,2,3,4,5)*
Controlled experiments	**	*			
Field observation	**	**	*		
Interviews of users	*	**	**		
Questionnaire survey of users	*	*	**		
Operating records—completion by drivers	*	*	*	*	
Interviews of drivers	*	*		*	**
Interviews of managers	*	*		*	**
Household interview in North Tyneside	**				

** primary source

* secondary source

Figures in brackets refer to objectives given in section 2.

tions of the basic dimensions of wheelchairs clearly was needed to evaluate the design of the vehicle and to develop the design guidelines required by the project brief. Accordingly the research programme was extended to include a household interview survey, which included measurement of wheelchairs. This was undertaken in the District of North Tyneside (Hall and Silcock, 1984).

Much of the data collection relied upon the vehicles' drivers and the managers of the operating organisations keeping adequate records. In the main this was done satisfactorily in Newcastle, Peterborough and Stoke. However, for the short period of operation in Edinburgh which is covered here, only limited data was collected.

The third area of difficulty arose because of the high proportion of multiple use of the taxi by some passengers. This meant that a significant part of the use of the vehicle was by the same group of people, on a regular basis. The questionnaire survey of users, which was implemented by the drivers, thus was reduced in scale due to the entirely reasonable reluctance of drivers repeatedly to ask the same passengers to complete the same form. It also meant that there were fewer individuals to survey, in total.

Use of the Prototypes

Type of Hirings

The different nature of the services provided by the four operators led to substantial differences in the types of hirings which the vehicles undertook in each placement. Table 2 illustrates this.

In Newcastle, all hirings from Community Transport were private or contract bookings; 86 percent of person-trips were booked by the individual traveling, thus the great majority of journeys are classified as private hire.

The two taxi operators used the vehicles in different ways. In Peterborough the CR6 replaced a licensed taxi and its pattern of business broadly reflects the nature of taxi operations by the company concerned; 65 percent of hirings were made through the dispatch office on a private hire basis. In Edinburgh the preferential treatment given to ECAS bookings for their disabled clients reverses the picture, the 81 percent of hirings being classified as contract hires through ECAS, although most probably are of a private hire nature.

The bus operator in Stoke began an experimental stage carriage basis towards the end of the placements. During the monitoring period this carried few passengers and as Table 2 reveals, private hire formed the bulk of the use of CR6 in Stoke.

Overall, therefore, it appears that the major market exploited by all four operators was that of individual journeys on a private hire basis. The passengers' views discussed later reveal that many of these journeys could not have been made at all in the absence of CR6.

Utilisation of the Vehicles

Summary statistics are presented in Table 3. The vehicles carried 10,334 passenger journeys on 6,160 hired vehicle-trips, although it must be noted that well over half of these took place in Peterborough. The mileage figures

TABLE 2

Type of Hirings—Vehicle Trips

	Newcastle		*Peterborough*		*Stoke*		*Edinburgh*	
	No.	*Percent*	*No.*	*Percent*	*No.*	*Percent*	*No.*	*Percent*
On-street or rank hire	N/A	—	1085	25	NA	—	89[1]	19
Radio call or telephone bookings for private hire	1029[1]	100	2784	65	286	79		
Contract hire pre-booked			409	10	61	17	382	81
Stage carriage	N/A	—	N/A	—	13	4	N/A	—
Total	**1029**	**100**	**4278**	**100**	**360**	**100**	**471**	**100**

N/A—not allowable in this operation

SOURCE: Operators' records

[1] Detailed breakdown not available.

Note: Contract hire generally implies booking 24 hours or more in advance.

in Table 3 also demonstrate that the CR6 was used most intensively by the commercial taxi operators in Peterborough and Edinburgh.

The reason for this is straightforward and lies in the nature of the operations, as can be seen when the type of passengers carried is examined only 12.5 percent of the passenger journeys in Peterborough were by disabled people and only 20 percent of the hired trips included a disabled pasenger. In Newcastle, by way of contrast, all but 3 journeys carried at least one disabled person. In Peterborough the taxi company was using the CR6 as a replacement for a conventional taxi, it thus carried disabled passengers largely in addition to conventional taxi trade whereas in Newcastle, Community Transport were providing a specialist service only to disabled passengers.

Although the CR6 was operated by a taxi company in Edinburgh, it was allocated on a priority basis to trips carrying disabled people and the opportunity for its use by other passengers was limited. Despite this, its overall use in Edinburgh was lower than expected.

During the period monitored approximately 2,070 journeys were made in the CR6's by wheelchair-users and 736 by ambulant disabled passengers. It is clear from these figures that use by disabled people was heavily biased to wheelchair-users, reflecting the nature of publicity for the vehicle and, perhaps, the very limited nature of the alternative means of transport available to this group of people.

Vehicle Occupancy

The highest average occupancies occurred in Stoke and Edinburgh. In Stoke, trips with disabled passengers had an average occupancy of 2.20 (excluding the driver); this fell to 1.25 in Edinburgh, whereas in contrast, trips without disabled passengers had their highest occupancy, 2.20, in Edinburgh. In Peterborough, average occupancy was 1.74 for both categories of journey. No clear picture emerges from these figures, but the Edinburgh occupancy of 1.25 for trips with disabled passengers and the figure of 1.44 for the same category of trips in Newcastle suggest that, where services are provided which cater particularly for disabled people, then a substantial proportion of them travel without escorts.

Frequency of Travel

Studies elsewhere of special transport services for disabled people have revealed a tendency for much of their use to be by a few individuals making many journeys. There was some evidence of this in the CR6 trials. In Newcastle, 30 percent of person-trips were accounted for by only four individuals and in Peterborough one regular contract accounted for 150 person-trips by one individual (16 percent of disabled passenger journeys). In Stoke, four passengers accounted for 34 percent of private hires and six passengers for all 163 contract hires. In Edinburgh six passengers made 21 percent of passenger trips.

TABLE 3

Utilisation of the Vehicles

Item	*Newcastle*	*Peterborough*	*Stoke*	*Edinburgh*	*Overall*
Total No. of hired vehicle trips	1029	4300	360[1]	471	6160
No. of hired vehicle trips per day in service	4.7	16.8	2.2	8.6	9.6
Total No. of passenger journeys carried	1446	7436	790	662	10,334
wheelchair users	745	803	282	240	2070
ambulant disabled	377	124	96	139	736
able bodied	304	6505	355	277	7441
category not known	20	4	57	6	87
Total No. of miles operated	11,917	37,150	9156	7000[2]	65,000[2]
in revenue service	4904	17,420	4578[2]	NK	NK
Average no. of miles operated per day in service	53.9	145.1	55.5	143[2]	101[2]
Mean hired trip length (miles)	4.6	4.0	14.75	NK	NK

[1] including 13 stage carriage journeys

[2] estimated

SOURCE: Placement reports based on operators' records.

Operating Costs and Revenues

The charging structure for the services offered in each placement varied widely. Similarly, so do the costs which can be attributed to the operation of CR6. This is clearly seen in Table 4.

Revenue per hired trip reflects the nature of the four operations. CT in Newcastle is a charitable organisation with low costs. They do not seek profits and their charges reflect the low cost structure—hence the lowest revenue per trip was obtained in Newcastle.

In Edinburgh and Peterborough the prevailing taxi fares during the trial periods were:

Peterborough—80p for the first mile and 50p per mile thereafter

Edinburgh—86.3p for the first mile and 46.3p per mile thereafter. When revenues per hired trip are viewed in the light of these similar fare structures, journey lengths in Edinburgh are seen to have been getting on for twice those in Peterborough. This is not implausible, given the size of the two urban areas and that ECAS covers all of the Edinburgh area.

Although the daily trip rate in Stoke was low, those trips which were undertaken earned high incomes, mainly due to the high proportion of long journeys and Flexibus' market pricing policy.

As can be seen from Table 4 no allowance is included for the capital cost of the vehicles, which were wholly met by the DOT. Operators met direct fuel and minor maintenance costs, normal insurance charges and, in some cases, drivers' wages. Administrative costs due to the presence of CR6 in the respective vehicle fleets have not been included.

The absence of capital charges resulted in each operator except Radiocabs making a nominal profit operating the CR6's on the terms of the placement contracts.

Conclusions on Operations

The major contribution of the CR6's in the localities in which they were operated was to carry 2070 wheelchair-user trips, the great majority of users being seated in their wheelchairs. For these passengers such travel had previously been impossible. The four operators clearly demonstrated the practicality of the concept of an accessible taxi in a variety of operating modes although its financial viability was questionable for services other than private hire.

The fact that each CR6 was unique in the areas in which the trials were conducted makes it well-nigh impossible to generalise from the results of the trials to a situation in which many more similar vehicles were operating in the towns concerned. In such circumstances, for conventional taxi operations, disabled passengers probably would form a very small part of the business as a whole.

For operations such as Community Transport, having aims to serve disadvantaged groups such as wheelchair-users, it is likely that the role of a CR6 type of vehicle would depend very much on how it were to be financed. Providing a very personalised service is costly, compared with group services via a minibus, and the scope for small vehicles probably is limited in such organisations.

The limited experience gained from the experimental stage-carriage service in Stoke is that it is not a realistic proposition to operate a state-carriage service for disabled people with a small vehicle. The reasons for the very low use of the service are not, however, clear from the limited monitoring which was possible.

TABLE 4

Summary of costs and revenues (in pounds sterling)

(1 pound sterling = $1.25 U.S.)

	Newcastle	*Peterborough*	*Stoke*	*Edinburgh*[5]
Total revenue	1404	9402	2560	1390
Revenue per hired trip	1.45	2.19	7.11	4.01
Fuel and minor maintenance costs	851	1922	592	810
Insurance[1]	430	400	13	100
Drivers' costs	nil[2]	2821[3]	1200[4]	551[3]
Total costs incurred by operator	**1281**	**5143**	**1805**	**1461**

[1] Standard cost to operator; additinal cost due to prototype nature of vehicle met by DTp.

[2] Met by MSC schemes, or volunteer drivers.

[3] Allowance of 30 percent of revenue; standard practice in the firm cncerned with self-employed drivers.

[4] Estimated

[5] For Radiocabs Ltd.

SOURCE: Operators' records

Passengers' Views

Data Sources

The primary sources of data for this section are self-completion questionnaires issued to users of the taxis during each placement.

Three similar questionnaires were used at each location, intended for completion by wheelchair-users, ambulant disabled passengers and able-bodied passengers (excluding escorts). It was originally intended that drivers would issue the appropriate form to all disabled users and by linking the returned questionnaires with other records the effects of multiple-use or regular travelers could be taken into account. In the event, drivers did not keep sufficiently accurate records for this to be practical and drivers, understandably, were unwilling repeatedly to ask regular users to complete the same questionnaire. However, with the aid of drivers' records and the responses to questions on frequency of use of the vehicle or whether a form had been completed before, a reasonable assessment of the number of individual respondents can be made.

Table 5 shows the number of passenger trips in each category, obtained from vehicle log-sheets, together with the number of returned questionnaires at each placement. The number of questionnaires in the group definitely known to include only one questionnaire per respondent is also shown.

The analysis presented here is based mainly upon the questionnaire returns; the interviews generally corroborate these. It is not clear whether it is more appropriate to concentrate analysis on the total number of questionnaires returned, thereby more accurately reflecting users' views on a per-trip basis, or to analyse just the first or only response, thereby reflecting users' views on a per-individual user basis. In practice little difference emerged between the results expressed in either form, implying that multiple users and single users hold similar views about the vehicles. The results presented here are based on total questionnaire returns, unless otherwise stated.

As can be seen from Table 5 there are limited results available in a number of categories, due mainly to the relatively short period over which data was available from Stoke and Edinburgh. There were also a limited number of passengers in some categories. The majority of the results presented relate, therefore, to an aggregated data set comprising returns from all four placements. Differences between the placements, where these can be detected, are discussed in the text.

In practice, around one-third of individual disabled users completed questionnaires, although at first sight Table 5 suggests that a very low response rate was obtained. This is explained by two main factors. First, the definition of passenger trip used here is a one-way

TABLE 5

Number of questionnaires returned and interviews conducted at each placement

	Newcastle	*Peterborough*	*Stoke*	*Edinburgh*	*Total*
Wheelchair-users					
Number of passenger trips	745	803	—	NA	NA
Total number of questionnaires returned	38	60	20	5	123
Number of first or only questionnaires returned by each individual	22	37	20	4	83
Numbler of interviews	11	8	—	—	19
Ambulant disabled passengers					
Number of passenger trips	315	92	—	NA	NA
Total number of questionnaires returned	27	28	1	9	65
Number of first or only questionnaires returned by each individual	16	10	1	9	36
Number of interviews	10	1	00	00	11
Able-bodied passengers					
Number of passenger trips	3	6505	—	NA	NA
Total number of questionnaires returned	2	127	9	00	138
Number of first or only questionnaires returned by each individual	1	79	8	—	88
Number of interviews	0	47	—	—	47

NA = Not available

TABLE 6

Frequency of use of CR6

Frequency of previous use of CR6	*Category of passenger*					
	Wheelchair User		*Ambulant Disabled*		*Able-bodied*	
	No.	*Percent*	*No.*	*Percent*	*No.*	*Percent*
Never	69	57	31	48	85	62
Once	20	16	9	14	20	14
2-5 times	20	16	18	27	25	18
6-10 times	4	3	4	6	4	3
More than 10 times	9	8	3	5	4	3
Total responses	**122**	**100**	**65**	**100**	**138**	**100**

SOURCES: questionnaire responses

TABLE 7

Journey purpose of respondents

Journey Purpose	*Category of passenger*					
	Wheelchair User		*Ambulant Disabled*		*Able-bodied*	
	No.	*Percent*	*No.*	*Percent*	*No.*	*Percent*
Work	1	1	—	—	24	18
Shopping	27	22	13	20	10	7
Education	2	2	1	2	2	2
Medical	16	13	13	20	7	5
Visit friends/relatives	27	22	15	23	40	29
Clubs/societies	15	12	9	14	14	10
Other leisure	20	16	8	12	24	18
Personal business	3	2	—	—	12	9
Other (including multiple purpose)	12	10	6	9	3	2
Total	**123**	**100**	**65**	**100**	**136**	**100**

SOURCE: questionnaire surveys

journey and most journeys made by disabled passengers were two-way. Secondly, a high proportion of disabled passengers made multiple journeys in the CR6. Thus, for example, the 803 passenger trips made by wheelchair-users in Peterborough represents some 400 return journeys by approximately 150 individuals. Sixty returned questionnaires thus represents about a 40 percent sample of individual travelers.

The multiple use of the CR6's by disabled passengers was quite marked, as shown in Table 6. This corroborates the comments made in the section on frequency of travel, based on operators' records. It should also be noted that the results presented in Table 6 will tend to underestimate long-run multiple use, because the data cover a limited period, before steady-state conditions had been achieved.

Characteristics of Passengers

As would be expected from national statistics, the disabled passengers were much older than the able-bodied and two-thirds of them were female. Twenty-two percent of wheelchair-users were under 50 years of age, a very similar proportion to that found in wheelchair-using residents of North Tyneside (Hall and Silcock, 1984) and in Fenwick's (1977) national survey of DHSS wheelchair-users.

Few disabled passengers were employed, compared with 60 percent of able-bodied passengers.

In response to the question, "do you or your immediate family own a car," 50 percent of able-bodied users answered "yes," whereas only 42 percent of wheelchair-users and 26 percent of ambulant disabled passengers answered "yes."

Disabled passengers were asked whether they were in receipt of mobility allowance; that is, a tax-free allowance of 988 pounds sterling per year to disabled people to help cover additional costs of mobility. Sixty percent of wheelchair-users but only 17 percent of ambulant disabled passengers reported that they were.

Characteristics of Journeys

The reported journey purpose of the CR6 passengers is given in Table 7. As would be expected from the limited number of disabled people in employment, work journeys are few. Visiting friends and relatives is a common purpose for all categories of users with leisure activities also being a common activity. More than half of all trips in the CR6 were for one or other of these two purposes.

Access and Egress for Disabled Users

Ambulant disabled respondents in all four placements were asked about use of the ramp. Twenty pecent made use of it to gain access. Wheelchair-users were not asked whether they used the ramp during the first placement because it was assumed that all would require it. When it became apparent that some drivers were not using the ramp to load wheelchairs then questions on ramp use were included at the start of the second placements. Of the 24 wheelchair-users completing this aspect of the questionnaire, only 4 (17 percent)had not used the ramp.

Only 8 wheelchair-users (7 percent) and 28 ambulant disabled passengers (47 percent) claimed that they could have managed to get in and out of the vehicle without help. The person helping was generally the driver. Table 8 shows where help was essential, in the respondent's view (note that this is not necessarily the same as where help actually was provided).

Comfort and Safety

Passengers were asked to indicate, on a semantic scale, their views on the comfort and safety of the CR6. Very few passengers, of any category, felt uncomfortable or unsafe in the prototypes. Stoke users gave the CR6 rather lower comfort and safety ratings than those in Newcastle and Peterborough, but the general response was very favourable indeed.

Changes in Mobility for Disabled Passengers

The accessible nature of the CR6 may well provide opportunities for travel which otherwise are denied. Disabled passengers were asked whether they could have made their current trip if this type of vehicle were not available. Forty-six out of 119 (39 percent) of wheelchair-users and 16 out of 64 (25 percent) of ambulant disabled passengers replied that they could not.

The responses to the question "how much difference to your travel would there be if all taxis were like this?" showed 94 percent of wheelchair-users responded "easier or "much easier," with a corresponding 73 percent of the ambulant disabled passengers responded similarly.

The alternative modes of travel stated by those passengers who said that they could have made their current journey if a CR6-like vehicle was not available are given in Table 9. As can be seen private cars and other taxi predominate.

Attitudes of able-bodied users

Able-bodied users were asked three supplementary questions to establish their frequency of taxi travel and attitudes to the prospect of all taxis being CR6's, possibly with higher fares.

About half of the able-bodied users traveled by taxi once a week or more. Two-thirds (91 out of 135) would not object at all were all taxis to be like the CR6 and only

TABLE 8

Where help was reported as essential by disabled passengers

	Category of passenger					
	Wheelchair User		*Sample Size*	*Ambulant Disabled*		*Sample Size*
	No. needing help	*Percent*		*No. needing help*	*Percent*	
Nowhere	3	2	121	26	43	61
In getting up the ramp or into the vehicle	109	90	121	29	48	61
In locating the wheelchair or getting into the seat	93	77	121	9	15	61
In fitting the restraint	48	53	90	NA	NA	—
In getting out	103	85	121	31	51	61

SOURCE: Questionnaire surveys

TABLE 9

Alternative modes of travel for disabled passengers were CR6 not to be available

Alternative mode if CR6 type taxi not available	*Category of passenger*			
	Wheelchair User		*Ambulant Disabled*	
	No. of mentions	*Percent*	*No. of mentions*	*Percent*
Walking or in wheelchair (alone)	4	4	2	3
Walking or in wheelchair (with helper)	7	7	2	3
Private car	25	26	10	14
Other type of taxi	30	32	35	51
Bus, train or metro	1	1	6	9
Social Service transport, ambulance or voluntary group vehicle	27	29	14	20
Other	1	1	—	—
Total number of times mode mentioned	**95**	**100**	**69**	**100**
Total respondents	79		54	

SOURCE: Questionnaire surveys

11 percent would object moderately or very much. However, most would be unwilling to pay higher fares because of the special nature of the taxi. Only 13 percent (18 out of 135) had no objection to paying a "somewhat higher fare" and 51 percent (69 out of 135) had a strong objection. Those who traveled more often by taxi were much less likely to accept a higher cost with equanimity.

Conclusions on Passengers' Views

Disabled users of the CR6's conform broadly to the disabled population as a whole, in terms of their age and sex.

Even with a vehicle designed to accommodate wheelchairs, 13 percent of those surveyed transferred from their chair to the passenger seat. Passengers preferred to travel facing forwards, with backwards facing being preferred to a sideways orientation.

The great majority of wheelchair-users and about half of the ambulant disabled passengers needed assistance at some stage when using the taxi. The most common place where help was needed was in entering or leaving the vehicle.

Passengers were very favourably impressed with the comfort and perceived safety of the vehicle. Disabled passengers, in general, showed very little inclination to criticise the CR6 in any way.

Over one-third of wheelchair-users and one-fourth of ambulant disabled users reported that they could not have made their current trip if the CR6 had not been available.

The great majority of disabled passengers thought that the CR6 had made their travel easier.

The able-bodied users who were surveyed were generally well-inclined towards the CR6 concept provided it did not lead to increased taxi fares for the general public.

Discussion and General Conclusions

The trials have seen the two prototypes operated in a variety of ways in the four placements. As described in an earlier section these have met with mixed results, in terms of demands and by implication, financial viability. Generally, the prototypes functioned very successfully as taxis or when providing private hire services. They had much less success when tried on a stage-carriage service in Stoke and their limited capacity resulted in few contract hires from organisations such as DHSS.

The predominant use of the vehicles by disabled people was for private hire, generally arranged by individuals. This accords with its basic role as a taxi and that the most intensive use during the trials occurred in Peterborough, where it was operated by a taxi company. The evidence from the other placements reinforces this, however, and suggests that there is limited scope for using CR6 or similar small vehicles for collective transport.

The section on passengers' views presents a picture of widespread approval from amongst those disabled passengers who used the prototypes; many of them more than once. For some, the CR6 had provided opportunities to travel which previously just did not exist.

Viewing the vehicle as a conventional taxi, its accessible nature does not appear to have detracted from its basic role, although this is very difficult to judge from the operation of a single vehicle in an area. Able-bodied users who were surveyed gave widespread support to the concept provided it did not lead to increases in taxi fares for the general public.

Almost all trips in the vehicles by disabled people were pre-booked. Until accessible taxis are much more widely available it is not possible to judge whether this was because only one vehicle was available or whether disabled people are more likely to seek the additional peace of mind gained from having made a firm booking for a taxi. The impressions gleaned from the home interviews forming part of the North Tyneside Wheelchair Size Survey suggest the latter hypothesis to be more likely.

The brave decision of Carbodies to allow public scrutiny and very early field testing of vehicles which were not yet at the engineering prototype stage has led to the collection of much useful data. It also allowed informed judgements to be made on design decisions which will have material benefits for the production model.

The conduct of trials and the other surveys and testing which surrounded them have provided a base to develop guidelines for the design of small vehicles which are intended to be accessible to disabled people. Such guidelines can be used by designers of vehicles which are intended from the outset to be accessible, or by those modifying production vehicles. They are also of interest to licensing authorities when considering changes to the permitted specification of taxis.

Overall, the trials have established the success of the CR6—in terms of its ability to transport disabled people—and have produced valuable information for those involved with their transport problems.

Acknowledgements

The work reported here was carried out under contract for the Vehicle Engineerng Deivision of the Vehicles and Systems Assessment Department of the Transport and Road Research Laboratory. The contribution of Mr. K. Holmes of that division is gratefully acknowledged.

Any views expressed in this paper are not necessarily those of the Department of Transport or the Transport and Road Research Laboratory.

Thanks are due to the following, without whose wholehearted cooperation the trials would not have been possible: Carbodies Ltd.; Community Transport, Newcastle; Boulton's Peterborough Taxis; Potteries Motor Traction Ltd.; Edinburgh Cripple Aid Society; Radiocabs (Edinburgh) Ltd.; and the passengers; and the staff and patients of cooperating institutions.

References

Fenwick, D. Survey of NHS supplied non-powered wheelchairs. OPCS survey Report 1027, 1977.

Hall, M.S. and D.T. Silcock. A Survey of the Sizes and Uses of Wheelchairs in North Tyneside. Forthcoming TRRL Supplementary Report, 1984.

M.S. Hall, Research Associate, D.T. Silcock, Deputy Director, J. Haigh, Project Engineer, and D. Hofmann, Director Design Unit, Transport Operations Research Unit, The University, Newcastle-upon-Tyne, England, NE1 7RU.

A HUMAN FACTORS FIELD EVALUATION OF SCAT, A VEHICLE FOR WITHIN-TERMINAL TRANSFER OF THE ELDERLY AND DISABLED

Ruth M. Heron and Uwe Rutenberg

Introduction

A notable problem in transferring disabled and semi-ambulatory passengers from one area of a large transportation terminal to another is that one attendant must be assigned to escort each wheelchair occupant. This arrangement not only puts a strain on available personnel resources, but also results in physical stress to those performing the task. Although some existing motorized vehicles allow more passengers to be handled at one time, none is directly accessible to wheelchair travellers who must, accordingly, transfer from the chair to the vehicle and back again at the within-terminal destination. SCAT (Small Carrier for Alternative Transport), designed by U. Rutenberg, M. Barber, and L. Goldik was conceived and developed by Transport Canada's Transportation Development Centre in recognition of this implied gap in transportation technology for the elderly and handicapped.

The development of SCAT included ergonomic input through conceptual, mockup, and prototype stages. Complementing this work, and designed to pinpoint any remaining system features needing modification, the field tests focused on (a) operator handling of both vehicle and passengers, (b) passenger reaction, and (c) performance of the vehicle in terms of procedures in a transportation terminal. This paper describes and reports results of these tests.

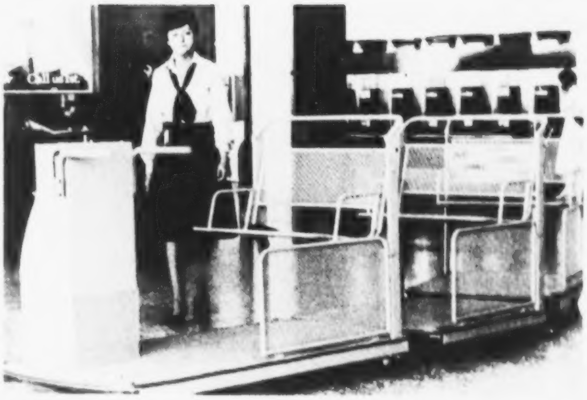


Figure 1. (a) A general view of SCAT.

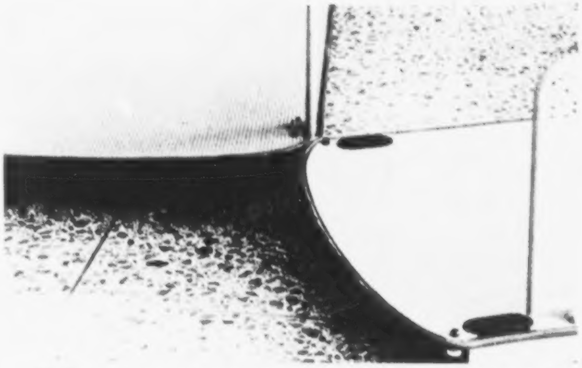


Figure 1. (b) A close-up two linked platforms during a turning manoeuver.

System Features

SCAT is a modular light-weight platform vehicle consisting of one 1.75 × .84-m motorized platform and one or more 1.22 × .84-m non-motorized platforms which may be linked together as needed. Linkage is effected by tie rods mounted crosswise on the underside of each platform (Rutenberg and Barber, 1982). As the ends of each platform are curved (radius = 1.5 m), two linked platforms then rotate against each other in opposite directions in a turning manoeuver, so that the turning radius with three linked units is only 2.45 m. Figures 1a and 1b provide,respectively, an overall view of the system, and an illustration of the turning mechanism.

Each platform is equipped with two fixed 10.2-cm castors on the rear: two front-mounted swivel castors complete the roll function for the non-motorized platform; on the motorized platform, one front swivel castor is mounted opposite the drive wheel. The ½ HP motor, positioned off centre to maximize space for manoeuvering a wheelchair, is driven by two 12V gel cell batteries; a gear box mounted directly on the drive wheel allows progressive speeds up to 5 kph; a built-in brake operates when the motor is stopped. Steering is accomplished by means of a tiller lined up with the drive wheel; designed to allow the driver to face either forward or backward, it rotates 180 degrees and translates along the long axis of the vehicle. A trigger at the end of the tiller permits gradual control of speed. Two hip-height metal driver perches (see Figure 2) offer support and/or stabilization to the standing driver who, thus, is able to see over the heads of pedestrians in the passageway.

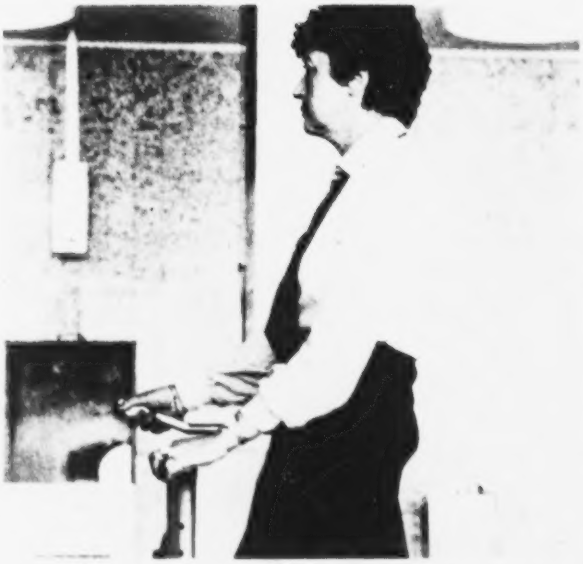


Figure 2. The operator sits back on the driver perch, gaining support and ballance.

The platforms, grey vinyl-covered 2-cm plywood with red vinyl tubing bumpers, are mounted on welded rectangular steel tubing frames. Each has a push rail, a fold-up seat with arm-rests, and a .76 × .42-m port-side ramp which folds up after use to act as a guard; these parts are made of steel tubing and perforated sheet metal spray-pointed a copen blue. The lower 14-cm height of the platforms was intended to permit easy access by elderly or semi-ambulatory passengers, and to keep the slope of the ramp a small 1:4 for accessibility by wheelchairs.

TABLE 1

Subject Characteristics and Test Functions

Subject	*Description*	*Test Functions*
Operators		
1	Air Canada attendant—male	—manipulation of controls —control of vehicle
2	Air canada attendant—male	—handling of wheelchair on and off the platform —mental and physical load
3	Air Canada attendant—female—small in stature	—male/female differences
4	Air Canada attendant—female—medium in stature	
Passengers		
1	elderly male—volunteer wheelchair dependent, but with upper body strength	—wheelchair accessibility and manoeuverability —sense of comfort, conspicuousness, safety
2	elderly male with wife volunteer—using one crutch—walking distance less than 10m	—accessibility by semi-ambulatory—seat comfort, sense of safety —push operation
3	male in 70s—actual passenger—using wheelchair temporarily to overcome distance to gate	—as for Subject 1 —check on social desirability effects in Subject 1's responses
4	as for Subject 3	—as for Subject 3

Method

Subjects

Four volunteer passengers were carefully selected to test out certain features of SCAT. In addition, two actual passengers asked for a test ride. Four volunteer operators were obtained through the auspices of Air Canada. Subject descriptions are set out in Table 1, along with their corresponding test functions.

Test Site

Time and money constraints dictated that only one site be selected. Dorval air terminal was a logical choice because of its proximity to the development site. Its size and layout are such that a comprehensive series of test scenarios could be devised.

Procedures

Each operator subject was shown how to (a) unlock, unfold, fold up, and lock both the ramp and the seat, (b) manoeuver a wheelchair onto and off both the motorized and non-motorized platforms, and (c) start, stop, and turn the vehicle. Each passenger subject was briefed on the nature and function of SCAT and assured of its safety before undertaking activities in accordance with the test functions outlined in Table 1.

Before actual trial runs, operators were given an opportunity to practice manoeuvering the vehicle as well as loading and unloading a wheelchair. Subsequently they guided SCAT from the ticket area through a doorway with 5.1 cm clearance to Security, into the waiting lounge and on to the farthest gate about 200 m distant, up and down two different loading bridges (with slopes of approximately 1:12 and 1:18 respectively), to Customs via elevator, to the baggage carousels, and finally, to the taxi area outside. These tests were extensively filmed. All operator and passenger subjects were encouraged to be critical; their free-flowing comments were taped, as were responses to specific probes regarding system features.

Results

Operator Tasks

Because manipulation of the positioning plates on the vertical seat support structure requires that both hands be used at once, some eye-hand coordination difficulty was experienced by subject operators in attempting to fold and unfold the seat. The remedial measure will involve a connecting rod with a handle so that both plates can be moved simultaneously.

Males tended to push the wheelchair forward up the ramp, females to pull it up backward. The latter mode of accessing the platform is less stressful than the former since, the small front revolving wheels of the chair are less able to overcome resistance on meeting the metal tubing lip of the ramp than are the large fixed rear wheels. More importantly, though, the backward pull-on movement allows the attendant to tilt the chair so that the occupant's weight is directly over the wheel axles, thus reducing physical load to the operator. Once the chair is on the platform, it can be easily manoeuvered into position by stepping backward onto the floor and working from behind the chair. Unloading is best done by rotating the chair into ramp-facing position, tilting it backward, and moving forward down the ramp. Clearly, training in use of the vehicle should include demonstration of these procedures.

Although the fixed position of the driver perch makes it impossible for operators of different heights to use it against the same part of the body, no complaints were received. Instead, reports indicate that usage of the perch will be determined by the height of the operators, the taller ones electing to sit on it, the shorter ones to lean against it. Although the forward-facing position was consistenly preferred, the additional perch will be retained, as drivers tended to rest the left hand on it for additonal balance.

Certain control difficulties were observed. For example, operators were inclined to pull the speed-control trigger too quickly at first, thus causing the heavily treaded drive wheel to spin; subsequent action of pulling the trigger even harder, while intended as corrective, only increased the wheel-spinning. Low control-response ratio, which would result in an overshoot response (McCormick and Sanders, 1982) and initial resistance in the trigger movement, which might induce the operator to apply excess pressure were ruled out as explanations. Rather it seems likely that the SCAT operator does not have auditory and kinesthetic feedback, familiar to the automobile driver, which would signal that the drive wheel is spinning; thus, believing that the vehicle is simply not responding to the control movement, the operator tends to pull the trigger still harder to obtain the desired vehicle response. When advised to press the trigger gently, operators were able to avoid wheel-spinning. Nevertheless, the trigger will be replaced with a thumb-operated sliding switch on the top of the tiller, the intent being to add visual feedback regarding amount of displacement of the control to that obtained through proprioception on pressing the trigger. The result hoped for is greater compatibility between perception of the vehicle's velocity obtained through kinesthetic, visual, and vestibular information (Bartley, 1969) and operation of the control.

Some initial difficulty in perceiving the relationship between the movement of the tiller and movement of the vehicle during turning manoeuvers was also evident. For example, drivers tended to operate the tiller too early in order to effect the turn required after entering the door to Security. Because of its very short turning radius, the correct strategy with SCAT is to move right to the door and then to turn sharply at low speed. A small amount of practice was sufficient to overcome all control problems with the observed sample, a fact suggesting that training in control of the vehicle, although necessary, would not be time-consuming.

The translational movement of the tiller proved serendipitously advantageous in that this control could be adjusted to the length of the arm of the driver regardless of the direction of facing. This feature can be considered important in light of the fact that operators would likely be drawn from both male and female populations and, therefore, would vary widely in body dimensions.

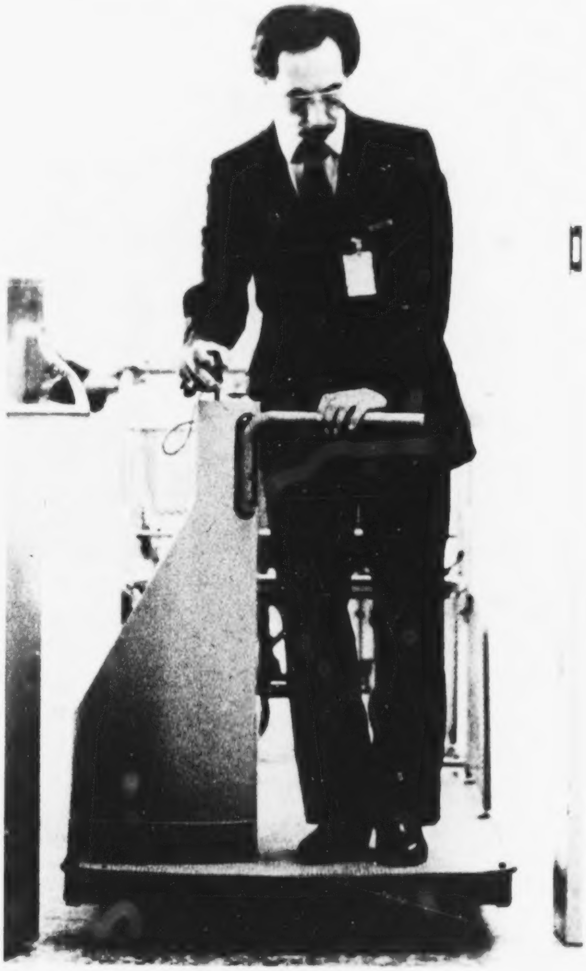


Figure 3. The operator guides SCAT through a narrow doorway.

In general, problems experienced with SCAT by subject operators were few and readily solved. A common comment by these volunteers was to the effect that such a vehicle would provide an effective answer to difficulties they now encounter in transferring special needs passengers. This is particularly true of females who, although they are on the average smaller in stature (McCormick and Sanders, 1982) and overall strength (Hosler and Morrow, 1982) than are males, are nevertheless usually assigned the task of escorting wheelchair passsengers to and from the bridge. The physical load incurred in these cases is particularly heavy on the ramps, and it would not be surprising to see increases in the incidence of back, knee, and shoulder strain among these employees. The real danger of course, as Tichauer (1978) points out, is that small effects may be ignored on a day-to-day basis only to surface cumulatively as a seriously debilitating problem some time in the future.

Passenger Considerations

Semi-ambulatory volunteer passengers found it very easy to step onto SCAT platforms, not only by reason of the low floor height but also the tubular driver perch and seat parts which they readily used for support. Despite their metal construction, seats were reportedly comfortable, due likely to their perforated and, hence, flexible nature. It can be noted, though, that the mother and child fully occupied one seat, so that two people of normal size would likely feel cramped if it were necessary for them to sit together for a long period. However SCAT was not conceived as a long-haul vehicle and, in order to keep it narrow enough to get through doors and into elevators, some compromise in seating is necessary.

A fully ambulatory individual could push a non-ambulatory or semi-ambulatory passenger if this mode were acceptable to airport authorities. The volunteer for this test, although elderly, found SCAT easy to manoeuver in this way, particularly since the design of the push rail leaves room for a good stride, and thereby, allowed her to maintain an erect posture while pushing.

All passenger volunteers spontaneously mentioned that a vehicle like SCAT would facilitate travel for them. Comments from the two actual passengers who had hitched a ride during the testing period were particularly favourable. In wheelchairs because of minor ambulation difficulties, they readily saw that they could have avoided use of a wheelchair altogether had SCAT been in service at the time.

However some uneasiness was observed on the ramps where it became clear that additional restraint of the wheelchair is desirable. To this end, the Mark II version of SCAT will have a 60-cm length of 1-cm sailcord attached with a cleat to the centre rear of each platform, and fashioned so as to hook over the rear crossbar of the wheelchair frame. In addition, of course, wheelchair passengers can avail themselves of the 5-cm nylon webbing lap belt, actually meant for seat passengers, by simply passing it under the armrests of the chair.

SCAT and Passenger-Handling Procedures

SCAT was able to negotiate the two bridge ramps attempted, both ascending and descending. However, aluminum joins on the flooring on these ramps did present some difficulty; the vehicle tending to stall with the drive wheel spinning. Some alleviation can be brought about by replacing the castors with pneumatic tires; still, inasmuch as the joins constitute a hazard for ambulating passengers and staff, the better solution would be to alter the flooring.

On the flat runs, the vehicle moves at about the same speed as the pedestrian traffic in a fluid and unobtrusive manner, even when three units are linked together. Subjects and passersby frequently referred to its aesthetic appearance which, unlike existing motorized units used in terminals, offsets any clinical connotation that might be associated with its mission. In Figure 3 the operator guides SCAT through a narrow doorway.

Use of SCAT on the elevator at Montreal's Dorval Airport involved disconnecting linked units and bringing each up or down separately. Nevertheless the vehicle would overcome the greater part of the burden of the current system which entails transfer of passengers in separate units from plane door to exit.

Conclusion

The prototype tests described above indicate, first, that only minor modifications are needed to render SCAT an ergonomically sound system. The Mark II version should then decrease physical load to those escorting special needs passengers to and from the bridge, provide comfortable and psychologically pleasing service to such passengers, and reduce demands on carriers' personnel resources. The vehicle could be useful also in other large complexes requiring movement of handicapped passengers.

References

U. Rutenberg and M. Barber, Modular Transfer Platform: Design Concept. (Les Designers Douglas Ball, Inc. Ste. Anne de Bellevue, P.Q., July 1982).

McCormick and M. Sanders, Human Factors Engineering and Design (5th ed.) (McGraw-Hill, New York, 1982).

S.H. Bartley, Principles of Perception (2nd ed.) (Harper and Row, New York, 1969).

W.W. Hosler, and J.R. Morrow, Jr. Arm and leg strength compared between young women and men after allowing for differences in body size and composition. Ergonomics, 25(4), 309-313, (1982).

E.R. Tichauer, The Biomechanical Basis of Ergonomics: Anatomy Applied to the Design of Work Situations. (Wiley, New York, 1978).

Acknowledgments

The reported study was carried out under the Elderly and Handicapped Program of Transport Canada's Transportation Development Centre in Montreal, Quebec, Canada. The authors gratefully acknowledge contributions by M. Barber and L. Goldik of Rutenberg Design Inc., F. Hare of Canadian Air Transport Administration, W. Rowan of Transportation Development Centre, Air Canada, and all volunteers.

Ruth M. Heron, Senior Research Officer, Transportation Development Centre, Transport Canada, Montreal, Quebec, Canada H2Z 1X4.

Uwe Rutenberg, Rutenberg Design, Inc., 480 Strathmore Blvd., Dorval, Quebec, Canada H9S 2J4.

DEVELOPING AND IMPLEMENTING FUNCTIONAL ELIGIBILITY CRITERIA FOR USERS OF SPECIALIZED TRANSPORTATION SERVICES

Judith G. Hollander and Robert M. Works

Introduction

It is generally required that users of specialized transportation services for the disabled register prior to receiving such service. The purpose of registration, or certification, procedures is to ensure that only persons who qualify for specialized transportation service will receive it. The determination of who "needs" these services, however, varies widely among specialized transportation systems.

Screening potential users becomes especially important in light of limited resources. Because of the demand-responsive nature of these services and the special equipment involved, subsidy levels per trip for specialized transportation are usually high when compared with those for regular route transit service. It is crucial therefore, that available resources be used to provide transportation to those who need it most and cannot use alternative modes because of their mobility limitation

A recapitulation of the recent experience of Metro Mobility, a specialized transportation service in the Minneapolis-St. Paul area, may be useful to other equivalent specialized systems grappling with the issue of methodology in certifying disabled riders.

Certification Systems

The Prior Metro Mobility Certification Procedure

Public transportation for handicapped persons unable to use regular route bus service in the Minneapolis-St. Paul metropolitan area is provided by a demand-responsive service, Metro Mobility. Metro Mobility is comprised of a variety of providers, including the Metropolitan Transit Commission (MTC), private tax operators, a non-profit group, and a private bus operator. All services are coordinated through a transportation center which screens applicants, receives trip requests, and allocates the trips among the different providers. No accessible mainline bus service is provided in the Minneapolis-St. Paul area.

In cooperation with its advisory group of elderly and handicapped consumers, the MTC and the Minnesota Department of Transportation (Mn/DOT) developed a certification scheme when Metro Mobility was initiated in 1979. These procedures required that an eligible Metro Mobility user be an individual who is unable to use or who has extreme difficulty using regular route transit services.

During the 1980 session of the Minnesota legislature, considerable discussion was held regarding eligibility for use of Metro Mobility and to what extent there was misuse of the system due to the use of inadequate certification criteria. As a result, Mn/DOT was mandated to develop and adopt revised rules to be used in determining individual eligibility for Metro Mobility.

Alternative Certification Systems

The first step in the development of new Metro Mobility certification criteria was the review of prior criteria used by local operators to determine eligibility for transit services for the handicapped. Certification procedures used to determine eligibility for specialized transportation services varied widely. Some operators allow any individual age 65 and over to use the service in addition to those who are physically handicapped, whereas others allow individuals with only certain types of disabilities to use their system. Still other operators utilize criteria that deal with specific limitations preventing an individual from using regular route transit service; some require individuals to participate in tests designed to measure mobility, many of which require doctor's verification of an individual's disability.

Limitations of Previous Certification Systems

Although the certification procedures used for Metro Mobility as well as those employed by other specialized transportation providers have a number of advantages in being easy to understand and administer, there were generally one or two important drawbacks. For example, systems using criteria which base eligibility on an individual's actual inability to use regular route transit do not deal with that person's ability to mentally orient him/herself within a transit system. Some systems do not certify individuals who may have a real need for specialized service. Conversely, in other systems where eligibility is based simply on age or on possession of a certain type of immobility, individuals who may not actually need special service are being certified to use it, or being assigned to a more expensive type of service than they actually need.

The previous Metro Mobility certification procedure represented one of the more liberal approaches. Although it worked reasonably well, a variety of issues and problems did arise. Responses on the application form regarding an individual's disability did not specifically indicate whether an individual could use regular route transit service rather than Metro Mobility. For example, if an individual used a wheelchair, it was assumed that person was unable to board a mainline bus, since regular route buses are not equipped with lifts in the Twin Cities area. However, in a case where an individual used some other mobility aid, such as a cane or crutches, or used no mobility aids, it was impossible to tell from the application form whether or not a person could in fact, use regular route transit services, or whether it was simply an inconvenience to do so. There were no questions designed to gather information regarding that individual functional limitations, only questions designed to determine if they were disabled in some fashion.

Another area of concern with the former certification system was that persons who were certified to use Metro Mobility were entitled to use Metro Mobility services throughout the year. There was some evidence to support the assertion that many handicapped individuals require the use of a specialized transportation system only during selected portions of the year. For example, during the winter months, individuals with certain types of lung and/or heart problems need Metro Mobility services yet are able to use conventional transit services during the less hostile period of the year.

Finally, there was concern with the former certification system in that specific information about registrants, such as age, or the presence of a visual, hearing or mental disability and information regarding additional assistance needed, was not specifically requested. This lack of information made it difficult for transit operators to identify and provide appropriate assistance to disabled passengers.

Purpose of Developing the Certification System

In reviewing both the previous certification system used in the Minneapolis-St. Paul metropolitan area, as well as the procedures employed in other metropolitan areas, certain difficulties in setting up a new system became apparent. At the heart of those issues was a need to clarify the purpose, or need, of a certification procedure.

The purpose of establishing eligibility criteria for special transportation services, as it has been defined in the Minneapolis-St. Paul metropolitan area, is to make sure that persons with mobility limitations receive the most appropriate transportation. A transportation service can be defined as "appropriate" if it meets a person's special needs in overcoming mobility barriers and:

- requires the least public subsidy, and
- causes the least possible inconvenience to the user.

Promoting appropriate transportation services is to some extent the positive version of controlling or eliminating "abuse". Under the previous Twin Cities certification system, abuse only occurred if a person used Metro Mobility without being certified. If a certified person who could ride the mainline bus used Metro Mobility, it could not be called an abuse. Rather, it was an inappropriate use of transportation services since the person could ride mainline buses at a lower subsidy. The most appropriate transportation mode could be accessible van or small bus, taxi, carpool or vanpool, and either accessible or inaccessible regular route transit.

How the New Certification System Works

Eligibility

Efforts were made to define more narrowly eligible Metro Mobility users as those who cannot use regular route transit service. In order to deal with the issues presented earlier, four basic criteria were developed, and are discussed below.

(1) Inability to maneuver oneself for a distance of at least one-quarter mile

The general spacing of regular bus stops within the Minneapolis-St Paul metropolitan area is at 1/4 mile intervals; therefore, if an individual is able to walk at least 1/4 mile, that person should be able to use regular route service assuming that the individual does not meet any of the other eligibility criteria. Data indicates that more than 90 percent of the current Metro Mobility users live within three blocks of a bus stop.

(2) Inability to climb and descend the bus steps of a mainline bus

The inability to go up and down the bus steps of a standard forty-foot bus can obviously limit one's ability to use regular route transit. Therefore, an individual who cannot climb 16 inches from the ground to the first bus step would be eligible to use Metro Mobility.

(3) Inability to wait outside for ten or more minutes

Research on current travel patterns indicates that approximately 80 percent of the trips currently taken on Metro Mobility requires a wait of 10 minutes or less at either the first boarding or any subsequent transfer if made on regular route bus lines. A current Metro Mobility user unable to ride regular route service would not usually have to wait more than 10 minutes for the vehicle to arrive, especially in the two central cities.

(4) Inability to use or learn to use mainline bus service due to a mental impairment or learning disability

Although the range of mental disabilities may vary considerably, it appears that a majority of individuals with these specific of disabilities can be trained to use regular route transit service with few problems. With the assistance of a trained Mobility Specialist currently working with the mentally handicapped, questions were developed to determine whether an individual with a mental handicap could use regular route transit service.

Additionally, the individual's need to use Metro Mobility year-round, and the availability of regular route transit training influence the way in which an individual is certified.

Conditional Certification

Conditional certification is granted to individuals who are not currently able to use regular route transit service, but could do so after training. This form of certification is granted for a period up to eighteen months, at intervals of six months, to allow individuals the opporturnity to receive appropriate training.

In determining eligibility, consideration is also given to the verification required in most cases by the appropriate professional.

Verfication

Verfication of an individual's disability by a physician, a certified physical therapist or a licensed psychologist is required for all individuals except those in wheelchairs or those who require lift equipped service.

In the past, verification of eligibility for Metro Mobility was required only when the individual had a "non visible" disability. By not requiring more extensive verification, it was claimed that more individuals than actually require the service have been certified to use Metro Mobility. Furthermore, some groups representing disabled individuals have indicated that the concept of verification is not popular with the handicapped community, and in many cases, a physician does not maintain the data that would enable determination of the necessary eligibility characteristics. Alternatively, others have suggested that verficiation is absolutely necessary to ensure that individuals are matched with the appropriate forms of transportation.

There are many ways to verify an individual's disability, ranging from a very controlled process whereby applicants would be screened by a board and asked to actually demonstrate their ability to use regular route transit service, to a very informal process whereby a person's statement would be considered sufficient for eligibility. The verification procedure outlined earlier represents a "middle ground" position that seems to be effective but not extremely costly, complicated, or degrading to individuals requesting certification. Its effectiveness rests on obtaining equivalent information from two different sources, the applicant and the health professional, and from asking specific questions on functional limitations affecting transit use. The option of using different types of health professionals should make it easier for applicants.

Appeals

Any individual who has been determined to be ineligible to use Metro Mobility has the oportunity to appeal that decision. The appeal is directed to the Manager of Metro Mobility, and later if necessary to an Appeals Board. This Appeals Board is made up of three individuals—a Metro Mobility user, a disabled regular route transit user and a medical technician. This combination tends to ensure that individuals selected would be familiar with functional limitations associated with disabilities and able to provide a variety of perspectives on that subject.

Seasonal Certification

A seasonal certification status allows eligible individuals to use Metro Mobility between November 1 and April 15. It has been added in an effort to recognize that while the disabilities of some individuals prevent them from being able to wait outside in below freezing tempratures, or able to navigate on icy and snowy sidewalks, etc. —conditions common to Minnesota during the winter months—they are often able to use regular route transit during the warmer months of the year.

How the New Certification Procedure Evolved

Public Involvement

In order to develop more effective criteria for individual eligibility to use Metro Mobility, a number of metro area organizations were directly involved in the discussion. Mn /DOT Transit Administration Staff organized a Certification Task Force (CTF) including both agency and consumer representatives, to serve this function.

Members of the Certification Task Force made presentations or consulted with ten user advocacy groups. The certification procedures went through the state's rule making process. The Adopted Rules were published in the State Register in August, 1982.

Recertification Process

In May, 1983, over 21,000 individuals, certified to use Metro Mobility were notified by mail that in order to continue to be eligible to use Metro Mobility, they would need to re-apply and meet the newly established criteria. About 16 percent, or 3,500 of these letters were returned to the Metro Mobility Transportation center either because the individuals were deceased or had moved.

As of June, 1984, approximately 9400 individuals had been certified to use Metro Mobility. Of those, it is estimated that 7,000 were previously certified to use the service and were recertified.

Impact

Meeting users' special transportation needs in the most appropriate and cost-effective method has been the guiding philosophy and purpose in developing and implementing the Metro Mobility recertification effort. The authors of this paper and the implementers of the qualifying program consider the philosophy of basing certification on functional limitations a sound approach for dealing with certification issues; however, new issues have surfaced in the course of implementation of new procedures. The purpose of the final section of this paper is to identify the outcomes of recertification in terms of ridership and related issues.

User Group

To reiterate, in January, 1983, 19,800 persons were registered to use Metro Mobility service. In June, 1984, about a year following the initial recertification mailing, there were 9,400 individuals certified to use the service Of the 9,400 individuals currently certified to use the service, it is estimated that 7,000 of these individuals were continuing users of the service

One can only speculate why the remaining 6,900 individuals chose not to seek certification to use the service. In the early years of Metro Mobility a major marketing effort was made to notify consumers about the service and to encourage them to sign up to use it. There was some speculation that many of those who originally became certified for the service never actually used the services so when they received the recertification materials they chose not to complete the forms. It was further believed that some of those previously registered to use the service may have realized that they would no longer qualify and chose not to re-apply. Data necessary to document these speculations was not collected, hence no firm conclusions can be drawn regarding those no longer using the service.

What is apparent from the limited data available, is that most user groups, as categorized for operational purposes, make up about the same percentage of the total ridership as they did the year prior, even though the total number of those registered has declined by over 50 percent. While there is no conclusive evidence of a change in the type of passengers carried by Metro Mobility, there is some indication that perhaps those without a specific functional disability chose not to be recertified and that those who do have functional limitations make up a larger portion of the clientele being served.

Ridership Consequences

While the total number of individuals certified to use Metro Mobility service has declined by over half during the year, ridership, on the other hand, has continued to increase. Between January, 1983, and June, 1984, the number of monthly rides on Metro Mobility increased by about 20 percent. It is difficult to isolate a specific reason for this growth, at a point in time when, the dispatching functions at the Metro Mobility Transporta Center were being computerized. Transit ridership generally in the Twin Cities seemed to be on the rise in response to improved economic conditions. However, it is the impression of many involved with the program that the recertification mailing to all users served as a kind of marketing and outreach compaign stimulating greater use of the service, thereby accounting for at least part of the ridership increase.

Data Base

One of the secondary goals, but primary impacts of the recertification efforts, has been the increased availability and refinement of data used for day-to-day operations. Specific information on clients, such as age, sight and hearing deficiencies, now appear on the record when developing trips for eligible individuals. As a result, Metro Mobility is able to provide better and more responsive service to its users.

User Conflict

At the outset, the guiding purpose of the new certification system was to insure that persons with mobility limitations received the most appropriate transportation.

Further, the certification system was designed to improve the match of those with particular functional limitations with the most appropriate form of service mode, i.e. accessible van or small bus, taxi, car or vanpool and regular route bus.

It was in the process of eliciting a person's functional limitation that some significant problems surfaced. For instance, a number of elderly blind persons disagreed with the criterion that required the applicant to verify that they had a learning disability. Also, it is believed that the criterion, as presently administered, enables increased use of Metro Mobility service by people with mental impairments who formally used mainline bus service.

This issue impacts mainly on blind persons who are frail and elderly. Because of the negative reaction registered by a number of people who feel that this criteria is not appropriate, an appeal was made to the state's Legislative Commission to Review Administrative Rules

(LCRAR) to change the requirement that such applicants undergo screening by a mobility specialist, in order to better ascertain their physical capabilities. The LCRAR recommended that the Administrative Rules process be amended to respond to this issue. Consequently, whether blindness is or is not a functional disability will be debated in the public hearing which is part of the rule amendment process.

Conclusions

The recertification process pursued by Metro Mobility has helped develop a sound philosophy and methodology for dealing with issues associated with certification. However, there have been some unforeseen negatives, in addition to positive results. For example, for those disabled by reason of blindness, the issue of certification is not yet resolved. Looking back over the steps in getting community participation in initiating the new criteria, it appears that a more intensive effort could have been made to bring the forces for and against automatic certification for the blind into a more collaborative position. The parties involved in the forthcoming rules amendment process will certainly face this issue head-on.

A number of positive outcomes have resulted from the recertification process. The most significant comes as a result of the detailed data base on users' individual disability characteristics. Dispatchers with the Metro Mobility Transportation Center are now more aware of a person's precise physical requirements so that appropriate driver and/or system response can be arranged.

Another major result has been the heightened awareness of the overall program through the actual recertification process. People seem to be better informed about what types of services are available for those with functional mobility limitations.

The recertification effort in the Twin Cities etropolitan area resulted in about a 50 percent decrease the number of individuals certified to use the service. This decline would have been reduced to about 40 percent had Metro Mobility purged its files earlier. It appears that many individuals who had been previously certified to use the service either determined that they were no longer eligible to use the service or they never did actually use the service, and thus chose not to complete the forms necessary to become recertified. Only about 2 to 3 percent of those applying for recertification were rejected; and of those, over 50 percent were rejected because their stated disability was blindness, a condition not allowed for in the rules as a functional limitation.

Although the number of individuals certified to use Metro Mobility service has declined significantly, the actual ridership continues to grow. While it is difficult to pinpoint the reasons for ridership growth, there is some evidence to suggest that the recertification mailing and subsequent public discussion served to remind users that the service existed, and thus prompted them either to begin using it or to increase their usage.

Additionally, the establishment of a certification approach based on an easy to understand functional mobility philosophy has promoted and will continue to promote an effective method of matching the passenger with a specific mobility limitation with the most appropriate available transportation mode. Finally, it is generally held by the affected agencies and the operators of the program that this scheme produced a positive response from the users, as well as from the people who now must make it work in the day-to-day operation of Metro Mobility.

Judith G. Hollander, Director of Special Services, Metropolitan Transit Commission, St. Paul, Minnesota 55101.

Robert M. Works, Director, Transit Program Section, Minnesota Department of Transportation, St. Paul, Minnesota 55155

IDENTIFYING AND EVALUATING SERVICE ALTERNATIVES FOR ELDERLY AND DISABLED PERSONS IN CHARLOTTE, NORTH CAROLINA

Katherine Hooper, Mary McGee, Joseph S. Revis

Background

The Charlotte Technical Assistance Project was an UMTA-funded project aimed at increasing the mobility of disabled persons. The project was initiated to offer expert assistance to selected transportation providers in order to improve or expand their services to the disabled. The Metrolina Independent Living Center (MILC) was selected as one out of four recipients of technical help. Sites in Minnesota, New Hampshire, and Michigan were also selected but are not reported here.

A technical assistance team from two consulting firms working with the MILC, the City of Charlotte, and Mecklenburg County, designed a technical assistance project whose specific objectives were to identify and define a number of transportation alternatives that could be used to improve the mobility of the disabled in the Charlotte area. Each alternative was evaluated in terms of the level of service provided, cost effectiveness and the relevance of the alternative to the needs and perceived desires of the disabled, such as, the quality of service. (See Tables 1 and 2.)

TABLE 1

Charlotte Technical Assistance Project

Service Alternatives Analysis

Evaluation Criteria

1. Independence and Mobility
    - Potential number of disabled to be served
    - Seat miles per day
    - Wheelchair seat miles per day
    - Passenger trips per 1000 disabled persons
2. Maximization of Trips and Service Coverage
    - Number of one-way passenger trips
    - Service area coverage in square miles
    - Daily vehicle miles per square miles
    - Daily route miles per square miles
3. Cost Effectiveness
    - Cost per passenger trip
    - Cost per vehicle mile
    - Cost per vehicle hour
    - Net operating deficit per day/year/trip
4. Service Quality
    - Average headway
    - Advance reservation requirement
    - Number of wheelchair positions
    - Number of seats
    - Number of transfers

TABLE 2

Charlotte Technical Assistance Project

(Technical Assistance Objectives, Service Alternatives, Evaluation Criteria, Level of Effort)

Objectives

1. To identify and define a number of transportation alternatives which could be used to provide increased mobility to the disabled in the City of Charlotte and, where relevant, Mecklenburg County.
2. To evaluate each alternative according to:
    - the level of service provided in terms of quality and quantity of the service,
    - the cost effectiveness in terms of the cost for specific levels of service, and
    - the relevance of the alternative to the transportation needs and perceived desires of the disabled.

Service Alternatives

I *Improved STS*—same service area, additional vehicles

II *Improved STS*—service area expanded to include Mecklenburg County and additional vehicles

III *Grid System*—based on MILC proposal

IV *Coordinated Human Service Transportation System*—based on survey results

Evaluation Criteria

1. Degree of increased mobility and independence
2. Number of trips and service area covered
3. Cost effectiveness
4. Quality of service

Level of effort

2.5 Person Months of Input-TA Staff

3.2 Person Months of Counterpart Support

Estimated Total Cost $15,000-TA Staff and Travel

TABLE 3

Charlotte Technical Assistance Project
Service Alternatives Analysis

Service Criteria Evaluation Measures

	Independence and Mobility					*Maximize Trips and Geographic Coverage*			*Cost Effectiveness of Service (Excluding Capital Costs)*				*Service Quality*				
Alternative Evaluated	*Target Population 15 years Or Older (With Mobility Impair'nts)*	*Seat Miles Per Day*	*WC Seat Miles Per Day*	*Passenger Trips/ 1000 Disabled Persons*	*Number of One-Way Passenger Trips Per Day*	*Service Area Coverage In Square Miles*	*Daily Vehicle Miles Per Square Miles*	*Daily Route Miles Per Square Mile*	*Cost/ Passenger Trip*	*Cost/ Vehicle Mile*	*Cost/ Vehicle Hour*	*Net Operator Deficit Per: Day Year Trip*	*Average Headway*	*Advance Reservation Requirement*	*Total Number Wheelchair Tiedowns*[1]	*Total Number of Seats*	*Number of Transfers*
Alternative I. STS Service Expansion (as planned)	13,500	19,840	9,920	7.75	105	143.3	4.3	N/A	$ 9.22	$1.56	$25.49	$ 879 223,000 8.36	N/A	48 hours	16	40	not required
Alternative II. STS Service Expansion (county-wide)	17,350	66,720	33,360	8.07	140	545.90	2.5	N/A	$11.84	$1.23	$29.39	$ 1,582 402,000 11.30	N/A	48 hours	24	60	not required
Alternative III. Fixed Route Grid System	13,550	182,160	24,288	14.02	190	143.30	5.3	.41	$12.43	$2.59	$20.51	$ 1,807 460,000 9.53	1 hour	N/A	32	240	maximum of one
Alternative IV. Coordination Center or Brokerage System	17,350	unknown	unknown	unknown	unknown	545.90	unknown	unknown	unknown	unknown	unknown	unknown	unknown	unknown	10	est. 960[2]	unknown

N/A Not Applicable

[1] Based on active fleet only

[2] Excluding sedans and stations wagons owned by 3 reporting cab companies (survey results)

SOURCE: J.S. Revis & Associates, Inc.

TABLE 4

Charlotte Technical Assistance Project
Service Alternatives Analysis

Summary of Simulation of Alternatives

Variables	*Alternative I. STS Service Expansion as Planned*		*Alternative II. STS Expansion County-Wide*		*Alternative III. Fixed Route Grid System*		*Alternative IV. Coordination Center or Brokerage System*	
A. Basic Characteristics								
1) System Coverage (square miles)	143.30		545.90		143.30		545.90	
2) Total Population	315,473		404,270		315,473		404,270	
3) Estimated No. of Mobility Impaired in Population (16 years and older)	13,550		17,350		13,550		13,550—17,350	
B. Service Assumptions								
1) No. Operating Days/Week (no nights or weekends)	5		5		5		As per agreement (could be 5 or more)	
No. Vehicles							40 agencies reported 21 having 402 vehicles; 17 agencies willing to share or pool 81 vehicles	
Active	4		6		8			
Spares	2		1		2			
3) System Capacity (Active Fleet Only)								
Seats	40		60		240		Est. 960	
Wheelchair Spaces	16		24		32		Unknown	
C. Operating Statistics								
1) One-Way Passenger Trips/Day	105		140		190		Unknown	
2) Total Vehicle Miles/Day	620		1,390		759		Unknown	
3) Total Operating Hour/Day	38		58		96		Unknown	
4) Total One-Way Passenger Trips/Mi.	.17		.10		.25		Unknown	
5) Total One-Way Passenger Trip/Hr.	2.75		2.41		1.98		Unknown	
6) Headway	N/A		N/A		Average: 1 hr.		Unknown	
7) Advance Reservation Requests	48 hours		48 hours		N/A		Unknown	
D. Estimated Costs and Revenues								
	With Capital	*Without Capital*	*With Capital*	*Without Capital*	*With Capital*	*Without Capital*		
1) Total Costs	$282,000	$246,000	$475,000	$433,000	$600,000	$500,000	$50,800	$75,000
2) Total Cost/Day	1,100	968	1,870	1,705	2,362	1,969	200	300
3) Total Cost/Vehicle Mile	1.79	1.56	1.35	1.23	3.11	2.59	Unknown	Unknown
4) Total Cost/Hour	29.22	25.49	32.24	29.39	24.61	20.51	Unknown	Unknown
5) Total Cost/One-Way Passenger Trip	10.57	9.22	13.00	11.84	12.43	10.36	Unknown	Unknown
6) Total Revenue	22,670	22,670	31,090	31,090	41,021	41,021	Unknown	Unknown
E. Estimated Net Operating Deficit	259,330	223,300	443,910	401,910	558,979	458,979	None	None
1) Total Operating Deficit/Day	1,021	879	1,748	1,582	2,201	1,807	None	None
2) Total Operating Deficit/Day	9.72	8.37	12.14	10.99	11.58	9.57	None	None
3) Total Operation Deficit/Vehicle Mi.	1.65	1.42	1.26	1.14	2.90	2.38	None	None

To undertake this task, a survey of City and County human service agency clients was conducted. In order to keep costs low, the agencies conducted the surveys under the guidance of a technical assistance team. From the survey, four options were identified and selected for detailed analysis. These options included: (1) an expansion of the present Specialized Transit System (STS) system by adding four more vehicles (as planned by the City); (2) expansion of the STS system so that its service area includes the City and the County; (3) an MILC proposed accessible fixed-route and scheduled system operating within 4 quadrants in the City of Charlotte; and (4) the development of a Coordinated Human Service Agency Transportation Center to more effectively use the existing transportation services and resources provided by the human service agencies in the area. (Table 2)

The alternatives analysis did not include an evaluation of the cost-effectiveness of making the present Charlotte Transit System accessible. The decision to exclude this option was based on two considerations. One, because of the limited budget available for analysis and assistance, the MILC in conjunction with the Technical Assistance Team, decided to concentrate effort on the four options described. Two, since a decision had already been made by the City to provide special services using STS (rather than mainline accessibility), it made a great deal more sense to evaluate the proposed STS expansion against alternative special service options.

Evaluation Approach and Results

The operating characteristics of each alternative were simulated and evaluated in terms of four criteria: (1) the degree of independence and mobility generated; (2) maximization of trips and service coverage; (3) cost effectiveness; and (4) the quality of service. The key findings of the evaluation have been summarized in Table 3 and in Table 4. The three service alternatives considered are shown in Table 5. A number of conclusions warrant highlighting.

TABLE 5

Charlotte Technical Assistance Project
Service Alernatives Analysis

(Key Service & Operating Assumptions)

Alternative I: STS City-Wide Expansion

1. *Levels of Service*
   - No change in service coverage from current STS service
   - The largely subscription character of the present STS service remains much the same with the level of demand largely set by supply constraints
   - The advance reservation time remains at 48 hours
   - The system fleet currently designated at 4 active and 2 spares for the proposed expansion was accepted and used for analysis
2. *Operating Assumptions*
   - More vehicles would permit better scheduling and positioning and thereby increase productivity. The improvement was assumed to increase from 2.0 pick-ups per hour at current STS service operating levels to 2.75.
   - Better scheduling and positioning would reduce the level of deadheading,and it was assumed that the average number of vehicles miles per vehicle per day would decline from the current level of 175 to 155.
   - There was an assumed related shift in vehicle miles per passenger trip from 8.75 to 7.75.

Alternative II: STS County-Wide Expansion

1. *Levels of Service*
   - The service area was assumed to increase from 143.3 sq. mi. to 545.9 sq. mi.
   - Using 1980 Census Tract data,the added target population to be served in the county was estimated to be 4,000 disabled persons for whom the service would be relevant (15 years or older)
   - Fleet requirements were estimated to be approximately 6 active and 1 spare.This assumed a somewhat lower spare ratio than Alternative I in order to limit the vehicle purchase requirement to 1 more vehicle.
2. *Operating Assumptions*
   - Trip demands and the distribution of trip ends (origins) was assumed to be directly related to the resident locations of the target population.There were 20 percent in incorporated areas and 80 percent in unincorporated areas
   - In terms of distribution of the destination end of the trips,the downtown area was used as a surrogate node for all potential locations within the City of Charlotte. A test of this assumption indicated that it would provide a reasonable basis for simulation.
   - Because of the rural area to be served by this alternative, trip lengths,vehicle miles and deadheading were all assumed to increase. The simulation indicated that the average number of vehicle miles per passenger would increase from about 8 at the current level of STS service to 16 for Alternative II

Alternative III: The Grid System

1. *Levels of Service*
   - Four fixed-route loops were designed to operate a scheduled service within four grids covering the City of Charlotte.
   - A common transfer point between each of the loops was provided in the Transit Mall in downtown Charlotte.

- Headways were developed so that the average headway was approximately one hour.
- All service was designed to be accessible with each bus having capacity for 4 wheel chairs and 30 regular seats.
- The fleet was estimated to consist of 8 active and 2 spare buses(as per criteria set by the MILC). During the simulation and the analysis thereafter,there were strong indications that a smaller vehicle would be more cost-effective.

2. *Operating Assumptions*
   - The system was assumed to operate independently of CTS with its own staff and management
   - Fares were assumed at the current STS level of 85c per trip.
   - Costs were simulated using city wage levels for system staff and operations and CTS unit costs for other vehicle operating and maintenance costs.
   - Staff requirements consisted of 13 operators(8 full-time and 2 part-time), a Manager, Director of Maintenance, Supervisor of Operations and administrative support.
   - To assure comparability with the other alternatives, 254 days was used as a service operating factor. This assumes that the Grid System would operate on a level comparable to Alternatives I and II.

Service Effectiveness

- In terms of the target population of disabled reached by the respective alternatives, the extension of the STS to include the County (Alternative II) provided the greatest coverage—about 17.4 thousand people 15 years or older with mobility impairments.

- Measured in terms of seat-miles and wheelchair-miles per day, the fixed route grid system (Alternative III), not surprisingly because of its fixed route and scheduled character, provided the highest level of seat-mile service (182 thousand seat-miles per annum). On the other hand, in terms of wheelchair seat-miles, Alternative II provided the greatest volume of service. The rural character of the County, to a considerable extent, explains the high level of wheelchair seat-miles.

- Measuring mobility in terms of the estimated number of passenger trips per 1000 disabled persons, the grid system showed the highest level of usage at 14 trips; the STS city-wide and the county-wide service options provided about 8 trips per 1000 population.

- Measured in terms of one-way trips per day, the performance of the grid system (with an estimated 190 one-way passenger trips per day) showed the greatest degree of utilization—about 35 percent higher than the county-wide STS alternative and almost double the proposed current STS expansion (Alternative I).

- The more extensive service area of Alternative II (county-wide STS service) is reflected in the 545 square miles that includes the County and City. One result of this substantially increased service area is a relatively low level of vehicle miles (2.5) per square mile of service area, in contrast to Alternatives I and III.

Cost Effectiveness

- Cost -effectiveness has been measured in three ways: cost per passenger trip, cost per vehicle mile, and cost per vehicle hour. Each has been expressed with and without capital costs and Table 3 presents these costs including capital costs. Specific findings:

  —Because of the fixed route and scheduled nature of the grid service, it had the highest vehicle mile and the lowest vehicle hour costs. It also had the highest cost per passenger trip and net operating deficit.

  —The currently proposed expansion of STS had the lowest cost per passenger trip ($9.22) and net operating deficit ($223 thousand) and on an overall basis balancing service against cost, is the most cost-effective alternative.

  —In terms of the net operating deficit, all the alternatives generated deficits with the largest associated with the grid system (Alternative III). This alternative generated an estimated net deficit of $460 thousand per year.

Service Quality and Operations

- In terms of the quality of service as measured by its accessibility and convenience attributes, the grid alternative provided the largest seat and the wheelchair/tie-down capacity. However, it also was likely to require at least one transfer in order to reach one of the grids or quadrants other than the one in which the rider starts his or her trip. The grid also provided the most frequent hourly service.

- The analysis suggests that the use of a smaller vehicle (e.g., a van or small bus) for a grid system would result in a more cost-effective result.

Coordination

- There was considerable interest and potential for a Coordinated Human Service Agency Transportation Center as the basis for improved mobility and transportation services for the disabled and agency clients.

Charlotte Technical Assistance Project
Human Service and Other Agency
Coordination Alternative

Exhibit 1

(Objectives—Strategies—Potentials)

Objectives

1. Coordinate capacity utilization for more cost-effective transportation and to provide added availability of services on the basis of pooled costs and service;
2. Improve quality of service;
3. Integrate of paratransit with conventional transit services. This includes linking paratransit with accessible transit services as a means to expand accessibility into a full service covering the entire trip from origin to destination (and not just stop-to-stop on transit).
4. Coordinate information systems and establish an information clearinghouse for all transportation services.
5. Cooperate in purchases of services and supplies in order to provide better prices through quantity purchases, greater expertise in specifications and equipment requirements, improved and lower operating costs for maintenance and parts purchases, and other operating and capital costs;
6. Explore the potentials for lowering overhead costs for participating projects;
7. Link public, private, and private-non-profit systems;
8. Develop varying levels of cooperation operating simultaneously among different groups of participants;
9. Monitor and evaluate of cost charges associated with cooperative efforts, i.e., cost savings/increases, trip charges, etc;
10. Provide a data base from which the impacts on costs and level of service from a staged coordination effort can be evaluated and measured;
11. Expand the development of cooperative effort using simple systems of limited scope and participation in a brokerage approach including a membership organization based on dues for part of its support.

Strategies

1. Develop a coordinated set of activites built around the concept of varying levels of participation including:
    - Voluntary Memberships at Minimal Costs
    - Cooperative Agreements
    - Coordinated and/or Integrated Programs
2. Develop a set of membership fees related to the level of participation (and therefore benefits) agreed to by each agency or organization.
3. Use specifically developed agreements to define responsibilities and requirements in terms of memberships, especially in terms of capacity-sharing and cost-sharing formulas.
4. Plan for an incremental approach that will permit the inclusion of not only public agency participants but private-non-profit and profit organizations as well.
5. Based on the survey of agencies, coordination appears to be feasible in terms of receptivity and potential service and cost benefits. It is worth doing irrespective of what decisions are made as regards the other alternatives.
6. A Coordination Center raises the least financial problems and should be designed so that its operations are self-supporting. Actual services provided by the Center should be charged in direct relation to the benefits received by recipients of the services.
7. Planning for such a Center or brokerage scheme should be linked with the County coordination about to get started and for which State planning funds have been provided.

Potentials

Exhibit: Peak and Normal Hours of Service of 18 Agencies Surveyed.

Exhibit: Coordination Potentials by Degree of Cooperation.

Exhibit: Coordination Potentials by Service Operating Function.

- A survey of the human service agencies indicated they were operating about 400 vehicles and spending about $1.4 million dollars on transportation in 1983. This estimate is low since it only covers the budgets reported by 56 agencies out of the 83 to whom the survey was mailed.

- Out of some 40 agencies responding to questions on their available capacity, about half indicated they had capacity available and were willing to pool or share this capacity in some way. Of related importance is the fact that about 60 percent of the agencies willing to pool their capacity were private-non-profit organizations rather than from the public sector.

- The private-for-profit sector added an additional 15 percent of respondents with transportation capacity available and willingness to share. Their interests, however, were more directly focussed on the sale of these services to human service agencies. They should not be ruled out, however, as participants in coordination. They can play an important role in supplementing agency capacity.

- The survey identified a wide range of interest in coordination activities including training, information sharing, coordinated data and management systems, coordinated vehicle use and maintenance and even centralized dispatching and operations.

- Given the considerable interest and potentials of coordination as indicated in the agency survey, this alternative was worth implementing irrespective of any of the other alternatives evaluated. (See Exhibit 1)

Recommendations

From the conclusions enumerated above and other aspects of the technical assistance, a number of important programs for improving the mobility of the disabled (and other target groups) in Charlotte suggested themselves. The strategies recommended for action are presented in this section. However, a number of comments are warranted.

To begin with, in terms of the findings of the technical assistance team, it is quite important to remember that the analysis did not examine the option of "mainline" accessibility on the Charlotte Transit System. The findings also must be interpreted in the context of the specific assumptions used in analyzing each of the alternatives.

It should also be quite apparent from the findings summarized in Table 3 that each of the alternatives have somewhat different features; there is typically a "trade-off" between service coverage, frequency, convenience, and costs.

Budget constraints are always an important consideration in transport planning and operations and, unquestionably, were important in planning the present operations and proposed expansion of STS. The level of the budget is an issue for local consideration and will (or should) reflect local priorities. However, there are always questions of balancing service quality against the amount of service provided. Therefore the simple choice of selecting the lowest cost alternative may not always result in selecting the best option. After all, the lowest cost alternative is to do nothing.

In the context of these considerations, there was no single clear choice that overwhelmingly dominated all the others. Trade-offs needed to be made and the following recommendations were provided in order to suggest strategies that warranted serious consideration.

1. In view of the strong interest shown in coordination by the agencies surveyed, the development of a coordination center warranted implementation irrespective of any action taken on the other alternatives.

2. It was recommended that the City develop a coordinated agency transportation program working with Mecklenburg County in their present effort. A general strategy for such an effort was described in the full report, and a generalized description for a lease rental approach was also included.

3. On an overall basis, balancing costs and service, the proposed service expansion of STS appeared to be the most cost effective approach. However, the addition of four vehicles did not appear to be sufficient to provide an adequate level of service and it was recommended that the expansion be increased to add at least one or two more vehicles. The scope of the addition would be set in the context of potential capacity that might be made available from a more coordinated effort among human service agencies currently providing transportation to clients.

4. The increment of cost associated with extending STS to county-wide service was estimated to be about $190 thousand. From the point of view of the County, this was probably a relatively lower cost than instituting a service separately. For the City, there would be added wheelchair and vehicle capacity. It was worthwhie for the City and County to consider negotiating a cost-sharing scheme based on mileage and administrative cost criteria.

5. The optimum scenario for improved service was the development of an integrated approach that included coordinated agency transportation services supported by City and County funds. These public agency transportation services could be used as a core for a regional transportation coordination center that would serve as a central clearing house and point of activity for public, private, and private-non-profit transportation. In that context, it was recommended that the City and County organize a joint planning group comprising interested

agencies and potential participants. Because of its ongoing regional network with City and County agencies, the MILC was an important focal point for this effort.

6. One service aspect not considered by the Technical Assistance Team was the development of a feeder service for the Charlotte Transit System with selective lift bus implementation. In addition, several cities have implemented "On-Call," fixed route, scheduled accessible transit service on regular transit. Both concepts warranted further exploration.

Katherine Hooper is with the American Public Transit Association, Washington, D.C.

Mary McGee and Joseph S. Revis are with J.S. Revis and Associates, Inc., 2804 Battery Place NW, Washington, D.C. 20016.

ESTIMATING THE DEMAND FOR SPECIAL TRANSPORT FOR DISABLED PEOPLE IN GREAT BRITAIN

Jean M. Hopkin

Introduction

Research over the last 10 years or so has shown that elderly and disabled people are heavily dependent on public transport as the majority live in households with out cars and may have difficulty walking (see for example Hillman, Henderson and Whalley (1976); Hopkin, Robson and Town (1978); Feeney, Ashford, Morris and Gazely (1979). Even in car-owning households, most elderly people are unable to drive and cannot therefore travel independently by car (Hopkin, 1981). Althouqh elderly and disabled people are largely dependent or bus travel for reaching destinations beyond walking distance, they experience a number of difficulties in using buses. In the past, many had dIfficulty in meeting cost of bus fares because most are on low incomes, but in much of Great Britain this problem has been alleviated or removed by the provision of concessionary fares (Hopkin, 1984). Physical difficulties with bus travel—getting on and off, moving around inside while the bus is moving, walking to the bus stop and standing waiting at the stop—remain a problem however; in some cases these problems are so severe that people are unable to take advantage of the fares concessions available to them because they cannot use public transport.

A number of developments in the provision of public transport suitable for elderly and disabled people have taken place in recent years in Great Britain. These have involved both modifications to conventional transport, and the provision of a variety of forms of special transport. A number of factors have influenced these developments. There has been an increase in awareness of transport problems experienced by elderly and disabled people, and groups representing them have become rather more vociferous (although not to the same extent as in the USA, for example). Transport operators have realized that elderly and handicapped people now form a large, and increasing, proportion of bus passengers; in Great Britain the National Travel surveys have shown an increase in the proportion of bus journeys made by people over pensionable age from 11 percent in 1965 (Mitchell, 1980) to 18 percent in 1978/9 (Department of Transport, 1983) while in Merseyside, the Passenger Transport Executive found that elderly and disabled people made 20.5 percent of all bus journeys in 1980 and 24.1 percent in the following year (Rihani, 1982). Legislative changes have encouraged the growth of special transport schemes by relaxing controls on features such as vehicle comfort, service characteristics, charging and advertising. The International Year of Disabled People in 1981 resulted in considerable publicity being given to transport problems, and since then substantial funds from central and local government have been made available for organisations setting up transport schemes, while cheap labour has been available through government-sponsored employment and training schemes. The role of these factors in the growth of special transport is discussed in detail in another paper prepared for this conference (Bailey, 1984).

Apart from the widespread introduction of buses with lower entry steps, developments have been piecemeal and a wide variety of types of transport have been introduced in different parts of the country. Because there has been no up-to-date and comprehensive information of the incidence of transport disability, services have been introduced on the basis of only rough, back-of-an-envelope estimates of the size of the potential market — either in terms of the number of potential users living in the area, or the amount of travel they wish to undertake. The philosophy appears to have been to fund as many types of service as possible, generally on an experimental basis (in that many are subsidised for a limited period initially), and assess the level of demand and the nature of people's travel requirements from the way in which the services are used. A National Advisory Unit for Community Transport has been set up with government funds to advise on operating special transport schemes and monitor their progress. In the future, as experience of these schemes is gained, and particularly if funds become more scarce, there will probably be a tendency to concentrate funds on a few types of provision that are most successful in terms of both the travel requirements they can meet and the cost-effectiveness of their operations.

There is therefore a need for a firm basis for assessing the market for such transport, both to assist organisations in setting up schemes, and for formulating policies on the package of measures that will best meet travel demand within given financial constraints. Questions on transport disability are planned for the next National Travel Survey, but as a step towards making the first national estimates of the market for improvements in public transport for elderly and disabled people, questions on difficulties with using local buses were included in the 1982 General Household Survey (GHS). This is an annual survey of about 20000 people aged 16 and over living in private households in Great Britain. It covers housing, migration, employment, health and education, and is one of the main sources for monitoring social conditions in Great Britain. This paper discusses some preliminary results of the survey and uses them to attempt and estimate of the scale of demand for various types of transport provision. A limited amount of information from other research is included where pertinent, but a comprehensive review of all the evidence available has not been attempted.

Background

1. The Incidence of Transport Disability

The only national source of detailed information on the number of disabled people and their problems is a survey conducted in 1968 (Harris, 1971). This survey provides detailed information on the incidence of various medical conditions and the functional disabilities associated with them, but did not cover difficulties with public transport. It showed that 7.8 percent of the population over the age of 16 were handicapped. If the rates of incidence among men and women of different ages remained the same this will have increased to 8.4 percent by 1981, through changes in the age structure of the population. This is over three times the number of people who have registered themselves as disabled with the social services department, so it is clear that there are large variations in the possible size of the disabled population, depending on how disability is defined. On the basis of local studies in Great Britain and more comprehensive investigations in Sweden and the USA. For example, Rihani (1982) concluded that probably around 5 percent of the population of Great Britain (including about 0.3 percent of the population who are in wheelchairs), experience difficulty using public transport; this was defined as "(a) Persons confined to wheelchairs and those whose ability to walk and climb steps is severly limited because of physical or sensory disabilities involving mainly paraplegics and quadriplegics. (b) Ambulant persons who suffer a temporary of permanent physical or sensory disability which results in hardship or danger in the use of passenger transport services". Some of the people with such difficulties would probably not be defined as disabled in the more usual sense of the term, while others who might be classified as having a disability would have no difficulty with using buses.

One of the most detailed sources of information on transport disability in Great Britain is a survey among a small sample of mobile people who registered as disabled in Coventry. Because the sample was small, and probably concentrated among the more severly disabled but mobile people (because those with more minor problems would be less likely to register themselves as disabled), it cannot be used to estimate the incidence of particular problems, but can be used to indicate their relative frequency. Just over helf of the people used buses, mostly with difficulty, and two-thirds of non-users were prevented from doing so by physical difficulties (Feeney et al, 1979). Nearly 80 percent of bus users had difficulty getting on and off, 90 percent had difficulty on the bus, three-quarters found standing waiting at bus stops difficult and half had trouble getting to the bus stop (Morris and Gazely, 1977). Table 1 shows the wide variety of problems experienced with the vehicles themselves, and suggests that improving bus design to suit such people is likely to be a complex task.

Research on bus design and bus accidents at Leyland Vehicles in conjunction with TRRL has produced guidelines for bus step heights, preferred seat heights and spacing, designs for handrails, and suggestions for control systems and driver training that could improve journey quality (Brooks, Ruffell-Smith and Ward, 1974; Brooks et al, 1980). Table 2 shows the problems experienced with bus travel by some of the subjects who participated in the experiments. It was estimated that for easy access by 90 percent of the population, bus steps would need to be inches (17.8 cm) high; step height was therefore considered to be an important factor influencing the use of buses by elderly and ambulant disabled people.

2. Developments in Transport Provision for Elderly and Disabled People in Great Britain

The Department of Transport has produced a comprehensive guide to transport for disabled people (Department of Transport, 1982), where details of the services available can be obtained. The main types of provision are summarised here. For people who are unable, or virtually unable, to walk the Mobility Allowance is a weekly income supplement intended to cover the additional transport costs involved in being very severely disabled. For ambulant disabled people, a number of types of provision are available.

Following the research on bus design by Leyland Vehicles (Brooks et al, 1974), the introduction of buses with lower entry-steps has become relatively widespread in the past few years; however it will obviously be many years before entire fleets are replaced by these new designs. Another feature which has become fairly common is the reserved seat for elderly and handicapped people near bus entrances to minimise the amount of movement which they have to make when inside the vehicle.

Other types of provision are far more localised, involving some form of special transport service. Bailey and Appleby (1983) identified 56 schemes operating in Great Britain in 1983. A directory showing the characteristics of 26 of these schemes (Appleby, 1983) gives detailed in-

TABLE 1

Difficulties with buses reported by disabled bus users in Coventry

Difficulty	Weighted %* of bus users
Getting on and off	
Bus parking too far from kerbs	65
Step height	61
Handling bags	53
Other passengers	13
Handrails	9
Platform width	1
On buses	
Bus moving off before seated	83
Moving to let others in/out	24
Leg room	20
Signalling for next stop	13
Handrails	11
Storage of bags	8
Seat height	7
Paying driver	5
Number of bus users	92

* Weighted to correct for differences between impairment of sample and population estimates.

Source: Morris and Gazeley, 1979.

TABLE 2

Difficulties with buses reported by elderly and disabled people

Difficulty	Disabled %	Elderly %	Lame/elderly %
Number of bus steps	44	19	43
Height of bus steps	87	78	93
Depth of bus steps	34	27	27
Width of bus entrance	15	11	10
Handrails at entrance	35	14	17
Handholds inside the bus	40	30	27
Getting into bus seats	62	27	33
Comfort of bus seats	29	46	23
Getting out of bus seats	59	32	50
Number of Subjects	116	37	30

Source: Brooks, Ruffell-Smith and Ward, 1974.

TABLE 3

Proportion of people aged 16+ with physical difficulty using buses

Difficulty	Bus user*	Non-user			Total
	%	Physical difficulty only reason %	Physical difficulty and other reasons %	Other reasons %	%
Getting on or off the bus	6	74	62	1	6
Getting to or from the seat	2	51	32	1	3
Getting to the bus stop	3	66	54	2	4
Waiting at the bus stop	2	50	39	1	3
Travel sickness	1	9	14	1	1
Other	2	10	12	1	2
Number of respondents	12264	444	188	6783	19679

* Bus users were people who had used local buses in the last 6 months.

Source: 1982 GHS

TABLE 4

Bus use and physical difficulty using buses: people aged 16+

Percentage of respondents

Frequency of bus use	Health difficulty with buses Yes	Health difficulty with buses No	Total
5+ days a week	0.9	12.0	12.9
2–4 days a week	1.9	13.1	15.0
1 day a week	1.1	9.0	10.1
1–2 days a month	0.9	8.7	9.7
Less often but in last 6 months	1.3	13.3	14.6
Not used in last 6 months			
– health difficulty only reason	2.2	–	2.2
– health difficulty and use car/no need	0.7	–	0.7
– health difficulty and other reason	0.2	–	0.2
– other reasons only	1.3	33.1	34.4
– housebound	0.3	–	0.3
Total	10.9	89.1	100

n = 19734

Source: 1982 GHS

TABLE 5

People with physical difficulty using buses: age and health

Percentage of respondents

Age	Limiting long-standing illness or disability Yes	Limiting long-standing illness or disability No	Total
16–44	8	6	14
45–64	23	5	28
65–74	23	4	27
75+	24	7	31
All aged 16+	77	23	100

n = 2075

Source: 1982 GHS

formation on the type of service provided, so the range of schemes is simply outlined here. In some areas, conventional buses have been adapted to be wheelchair-accessible with lifts or ramps for use on scheduled stage-carriage services which operate on one or two days each week from residential areas into the town center, so that people living in different parts of the town can all benefit from just one or two vehicles. South Yorkshire Passenger Transport Executive operate "kneeling" buses and "split step" buses on some bus routes—essentially two inexpensive modifications to conventional vehicles that reduce the height of the first step for passengers when boarding (for details see Oxley and Benwell, 1983). In some other areas, helpers on the vehicles assist elderly and handicapped people. Because many such people fear poor driving on buses (and they are centainly far more prone to falls and accidents on buses than other passengers (Brooks et al, 1980), at least one operator has introduced bus services which are always driven by the same person (Taylor, 1982). In addition to these improvements to conventional bus services, a variety of unconventional services have developed, mostly providing door-to-door services. There are two basic types: dial-a-rides using adapted minibuses and cars in which rides are shared with other passengers, and taxi services. Within these two types of service there are many variations; some provide services to specific destinations such as hospitals or shopping centres while others are as close as possible to conventional public transport in that users can travel to any destination within the area served. Many require advance booking, which means that journeys have to be planned. Most vehicles are equipped with lifts or ramps and have flexible seating arrangements to allow for carrying different numbers of people in wheelchairs, some also provide helpers to assit passengers. In London, a subsidised taxi scheme enables disabled people who can use taxis to travel cheaply (Foulkes and Howard, 1983). Eligibility criteria vary but generally the schemes are for people who are unable to use public transport.

3. The General Household Survey

As mentioned earlier, the data described in this paper are preliminary results from the 1982 General Household Survey (GHS). Full details of the survey procedure and the main results are given in the survey report (Office of Population Censuses and Surveys, 1984). The section on bus travel included questions on use of local bus services and difficulties with bus use—due to health problems and for other reasons. Questions were phrased in a way that would elicit spontaneous, unprompted descriptions of people's difficulties described in fairly general terms. Because it is a general purpose survey, people's disabilities were not covered in detail but people with a "long-standing illness, disability or infirmity" which "limits activities" in some way can be identified.

Use of the survey for estimating the demand for disabled people's transport has a number of limitations which need to be borne in mind. Questions on bus travel were only asked of people aged 16 or over so estimates for the whole population cannot be made directly. Because physical difficulties with using buses are complex and a wide variety of tasks are involved, solutions to these problems are also complex; estimates of the number of people who might benefit from particular kinds of solutions can only be made in very broad terms from the survey — it is not possible to identify the market for particular kinds of adapted vehicle, for example. In additional, some solutions suit people with one type of disability but not others. The estimates are based on a description of problems experienced with the type of public transport which is currently available—which for most people still means the conventional, unmodified, bus. It is not necessarily true therefore that if present problems are overcome, elderly and disabled people will be able to use buses in the same way as others since other problems may emerge. The demand for travel implied by the survey can only be estimated in general terms because the only travel data collected was frequency of bus use (in approximate number of days on which buses were used) during the last prior months; some indication of travel demand is gained by reference to other surveys.

The Demand for Special Transport

1. Problems With Bus Travel

Ten per cent of respondents in the GHS reported experiencing a health problem that made bus use difficult for them. Table 3 shows that difficulty getting on and off was the most common problem, followed by getting to the bus stop; waiting at the bus stop, moving to and from seats and travel sickness were less common.

For some people, these problems did not appear to affect bus use, but others travelled less frequently by bus if they had difficulty and some respondents reported that they did not use buses because of this physical difficulty. In some cases, this was the only reason for not using buses, but in others, factors such as having a car available also played a part (see Table 4).

Three-fifths of people reporting physical dificulties with bus use were over the age of 65, and three-quarters reported a limiting long-standing illness or disability, but some of those with difficulties were neither old or suffering from limiting illness or disability, as Table 5 shows. Figure 1 shows that the proportion of people reporting physical difficulties increased dramatically with age. Three-fifths of those with such difficulties lived in households without a car (see Table 6); in all age groups, people with diffculty were less likely to live in car-owning households, and were therefore more dependent on public

TABLE 6

People with physical difficulty using buses: age and household car ownership

Percentage of respondents

Age	Number of household cars 0	1	2+	Total
16–44	5	7	2	14
45–64	13	11	4	28
65–74	18	8	1	27
75+	25	5	1	31
All aged 16+	61	31	8	100

Source: 1982 GHS

n = 2088

TABLE 7

People with physical difficulty using buses: age and working status

Percentage of respondents

Age	Working	Not working	Total
16–29	3	3	5
30–44	4	5	9
45–64	8	20	28
65+	1	57	58
All aged 16+	17	83	100

Source: 1982 GHS

n = 2089

TABLE 8

Proportion of people aged 16+ with other difficulties using buses

Difficulty	Bus user %	Non-user %	Total %
Bus service unsuitable	15	22	18
Expense of bus travel	11	11	11
Coping with children	3	1	2
Coping with shopping	2	*	1
Other	3	1	2
Number of respondents	12271	7579	19850

* Less than 0.5 per cent

Source: 1982 GHS

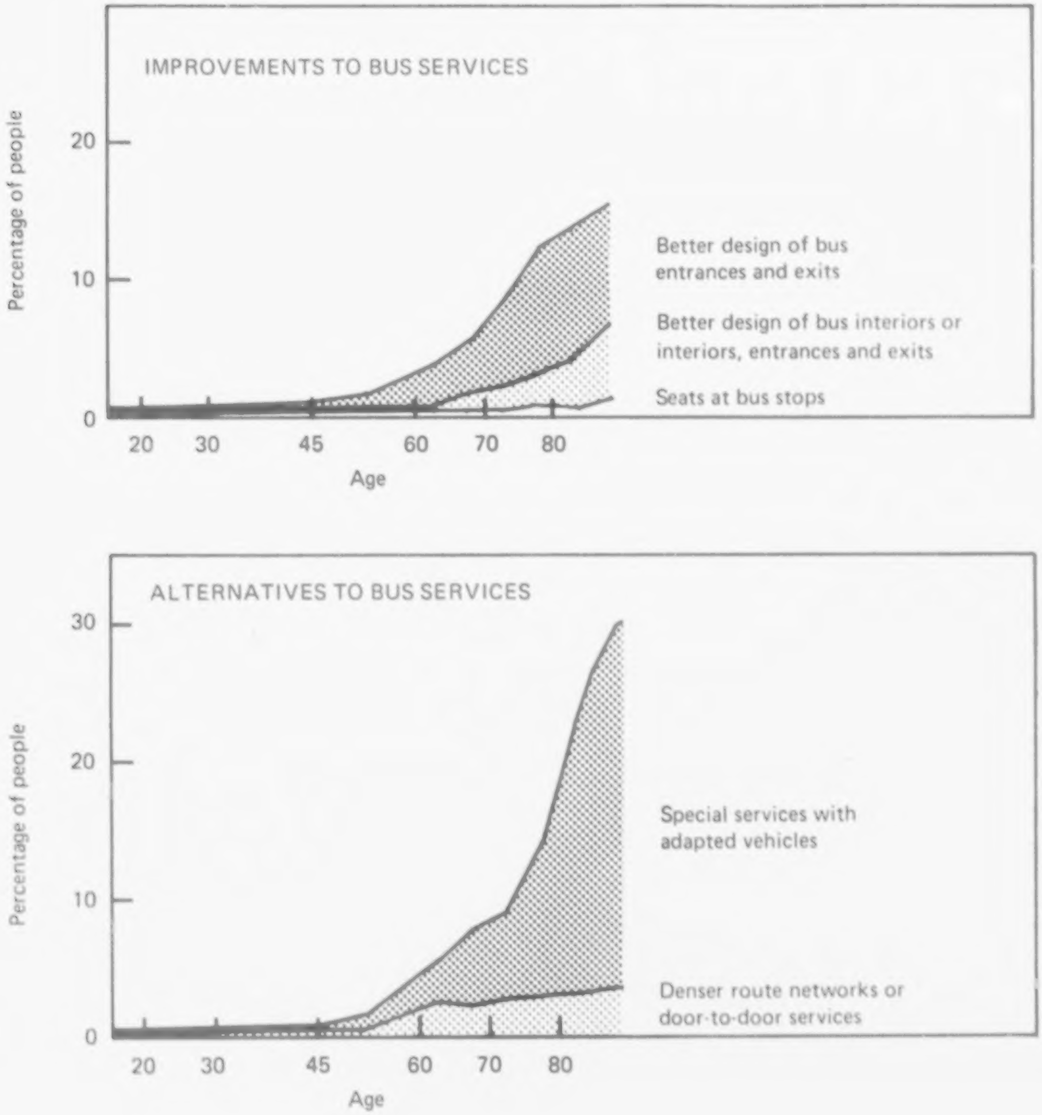


Fig. 1 **Proportion of people in each age group forming the main market for improvements in bus services**

transport for journeys beyond walking distance, than were people without physical difficulty using buses. Most people with such difficulty were economically inactive: only 17 per cent were working (see Table 7), so the large majority would probably not have been able to afford to pay for taxis to avoid difficulties of bus travel; people with difficulty using buses were less likely to be working than those of similar ages without difficulty. A third of those with difficulty were living alone, and would therefore have had to travel to take part in day-to-day activities.

In additional to these difficulties with bus use associated with health problems, other problems were also mentioned. The main difficulty was that bus services were unsuitable, as Table 8 shows; this dificulty was more likely to be reported by non bus users (for whom it was reported as a reason for not using buses), than by bus users. The expense of bus travel was the other main problems; among bus users this was about twice as likely to be mentioned by people under pensionable age as by older people, presumably because fares are provided for many people over pensionable age.

TABLE 9

Characteristics of people who would benefit from public transport improvements

Percentage of respondents

a) Age and car ownership

	No household car	Household with car	Total
16–19	0.8	0.8	1.6
20–29	1.5	1.9	3.4
30–44	3.7	4.2	7.9
45–59	8.1	7.4	15.5
60–64	7.8	3.4	11.2
65–69	9.2	4.0	13.2
70–74	12.1	3.1	15.3
75–79	13.6	2.1	15.6
80–84	9.1	1.0	10.1
85+	5.3	0.8	6.2
Total	71.2	28.8	100
			n = 1657

b) Age and limiting long-standing illness or disability

	With limiting illness	No limiting illness	
16–29	2.0	3.1	
30–44	5.4	2.5	
45–64	21.5	4.9	
65–69	10.9	2.2	
70–74	12.7	2.6	
75–79	12.4	3.1	
80+	12.6	3.6	
Total	77.4	22.6	n = 1657

c) Age and household type

	Alone	Elderly people only	Other
16–29	0.2		4.8
30–44	0.4		7.5
45–64	5.2		21.5
65–74	10.6	11.3	6.6
75+	17.7	9.4	4.7
Total	34.2	20.7	45.1
			n = 1657

d) Age and working status

	Full time	Part time	Unemployed	Other
16–64	8.2	4.6	2.3	24.7
65+	0.2	1.0	0.1	59.0
Total	8.4	5.6	2.4	83.7
				n = 1655

Source: 1982 GHS

2. The General Market for Improvements in Public Transport

The people who might reasonably be expected to benefit from improvements to bus design and operations aimed at assisting elderly and disabled people, are bus users defined as those who had used local bus services in the last 6 months, experiencing physical difficulty using buses, and non-users for whom physical difficulty is the only reason for not using buses. These two groups together amounted to 8.3 percent of the people over 16 in the GHS, and included 30 percent of those with a limiting long-standing illness or disability. Thus 8.3 percent of the population over 16 (or 3.5 million people in Great Britain) would be likely to benefit directly if it were possible to make enough improvements to bus services of the kind described earlier to overcome all the problems experienced by elderly and disabled people. It would be rather optimistic to expect that people with physical difficulty who also had other reasons for not using buses would begin to use buses (or alternatives to conventional bus services) if these improvements were made. But if people with physical difficulty and reasons other than not needing to use buses could be attracted onto buses, the proportion of people benefitting would increase to 8.6 percent. Other people, such as those who have difficulty coping with their children and shopping when travelling by bus, would probably also benefit to some extent.

Table 9 shows some of the characteristics of the people in the GHS who constituted the main market for improvements in public transport for elderly and disabled people. More than two-thirds of them were women, a third were over 75, and a third lived alone and half were elderly people in non car-owning households; half were elderly and suffering from a limiting long-standing illness or disability, while a quarter were younger people with such a disability. Almost three-quarters were bus users, and a third used buses at least two days each week.

3. The Market for Particular Types of Transport Improvement

It is likely that many of the people with more than one physical problem preventing them from using buses would be unable to use buses unless all of their problems could be overcome. The number of people who might benefit from individual types of improvement depends on the way in which problems combine for different groups of people. Table 10 shows estimates of the proportion of the sample who were members of the group defined as most likely to benefit and who reported various combinations of problems. From this, the market for different types of improvement can be estimated, although accurate figures are not yet available.

a) *Modifications to Conventional Services.*

Table 10 suggests that the simplest single measure that would benefit the largest group of people without altering the nature of the service provided is improving the design of bus entrance and exits. Two percent of people over 16 would probably benefit and this could be increas-

TABLE 10

Estimated proportion of people with various combinations of difficulties with bus use

Difficulties with bus use	Bus user %	Non-user, physical difficulty sole reason %	Total %
1. Getting on or off the bus only	2.8	0.9	2.0
2. Getting to or from the seat only or getting to or from the seat and getting on and off the bus	0.8	0.4	0.6
3. Waiting at the bus stop only	0.3	0.1	0.2
4. Getting to the bus stop only or getting to the bus stop and waiting	1.3	1.0	1.2
5. On-vehicle and bus stop	2.0	3.2	2.5
6. Other	2.7	0.4	1.8
Number of respondents	12280	7580	19860

Source: 1982 GHS

ed to 2.6 percent (or 1.1 million people over 16 in Great Britain) if in addition, people's problems moving around inside buses could be overcome. These people were rather older than those forming the general market for improved services shown in Table 9; 54 percent were over the age of 70. The kind of improvements which are involved include lower steps, better placed and designed handrails and bell pushes, wider spaces between seats, reserved seats near bus entrances, improved ride characteristics, providing helpers, and waiting until all elderly and disabled passengers are seated before driving off. The research on "split step" and "kneeling" buses in Sheffield (Oxley and Benwell, 1983) suggested that improving the design of bus entrances does make it easier to use buses, because people using the modified vehicles were more likely to report that they had problems moving around inside buses than to report problems getting on them, whereas Table 3 shows that problems boarding and alighting are three times more common among bus users, than problems moving around inside buses. Experimental work at Cranfield reported in another paper at this conference (Oxley, 1984a) has suggested various design improvements that would help this group of people, and suggested that bus operating times might increase by about 1 percent if drivers waited until all disabled people were seated before moving off, and by rather less than 2 percent if disabled passengers alighting also remained seated until the bus had stopped.

The other measure that could be implemented without changing the type of bus service provided or involving vast expense, is to provide seats and shelters at all bus stops. Table 10 suggests that this would assist 0.2 percent of people over 16 who have difficulty waiting for buses and no other problem (including some who reported that physical difficulty prevented them from using buses); other bus passengers would also benefit. One study reported that 98 percent of disabled bus users did not have a seat at their nearest stop (Morris and Gazely, 1977). The people reporting difficulty waiting at bus stops were more likely to be under 65 and suffering from limiting long-standing illness than those in other groups of potential beneficiaries of bus service improvements.

The three types of measures aimed at assisting elderly and disabled bus users on conventional services would probably meet the needs of about a third of all the people in the GHS identified as the potential market for such improvements. The fact that only about a sixth of them

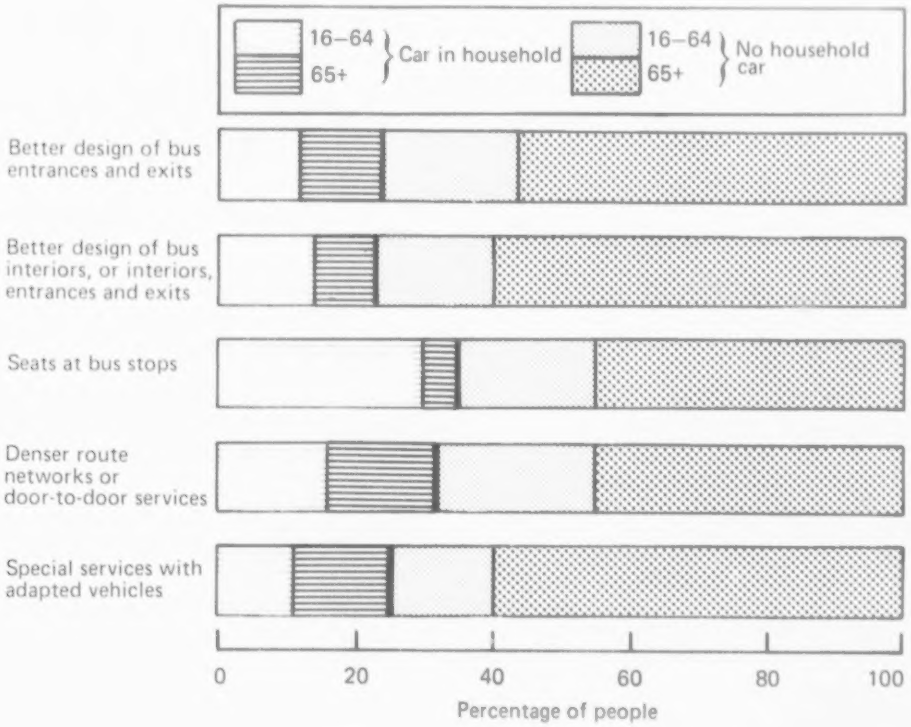


Fig. 2 Age and household car ownership in the main market groups for improvements in bus services

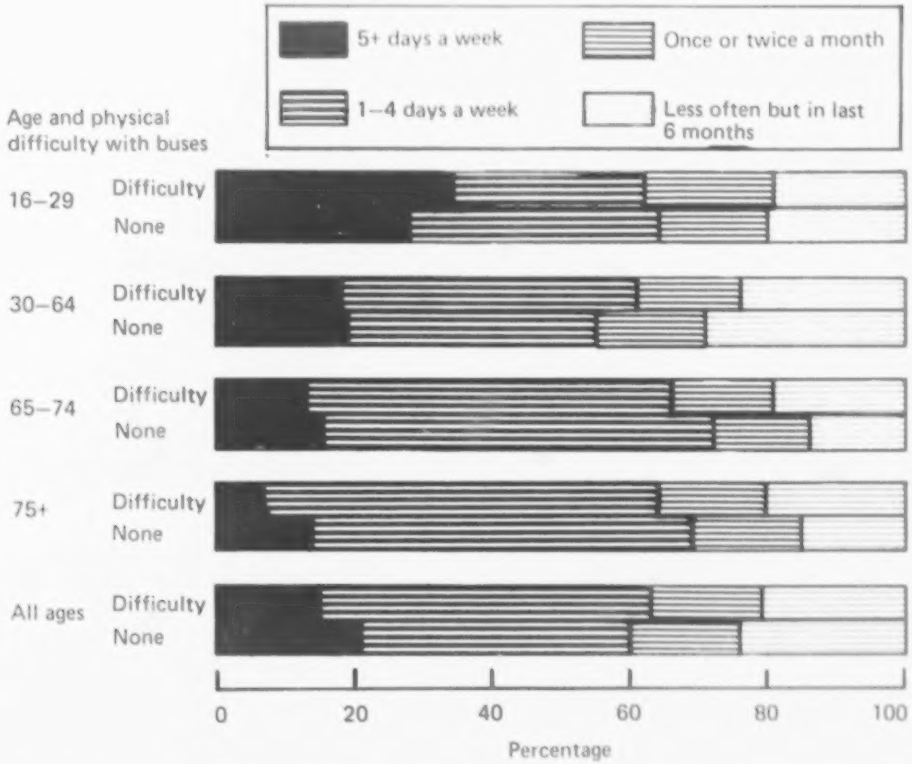


Fig. 3 Frequency of bus use, age and physical difficulty among bus users

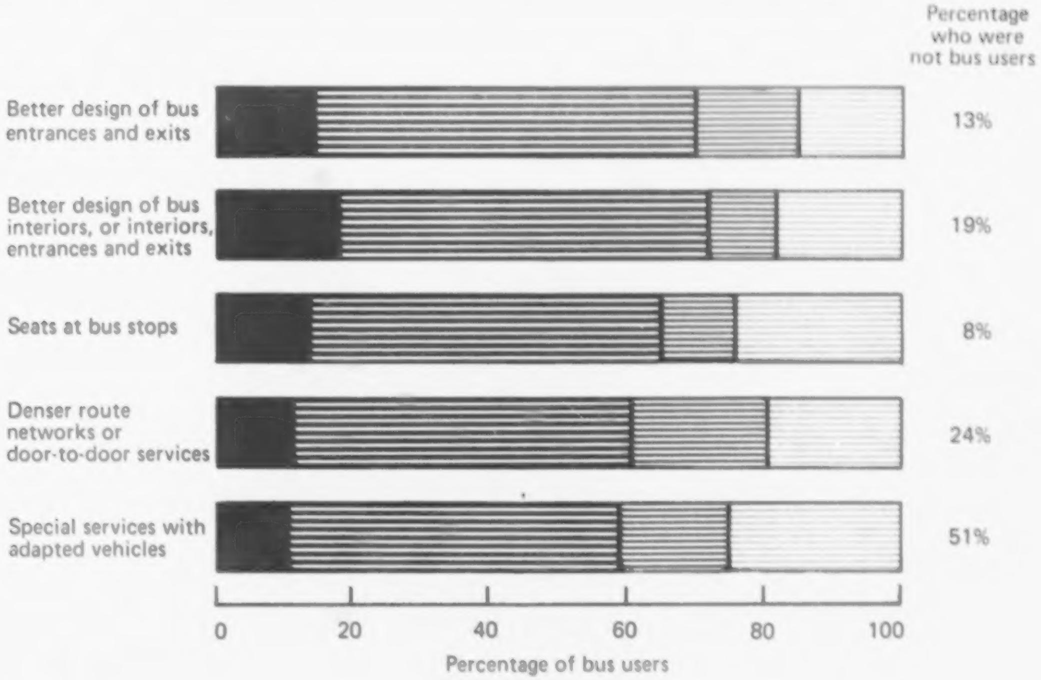


Fig. 4 Frequency of bus use among the main market for improvements in bus services

were not bus users suggests that modifications to conventional stage carriage services, rather than the provision of alternative services with more suitable vehicles, is likely to be the most cost-effective solution. For most of the remainder, however alternative types of services might be more appropriate.

b) *Alternative Services.*

For one of the remaining groups, those with difficulties on buses and reaching the bus stop, door-to-door services using special vehicles are the obvious solution. The fact that half of them were unable to use local buses, while those who could used them less often than people with other types of difficulty, substantiates the case for alternative types of service. There are two main types of service which could be provided: subsidised taxis, and door-to-door special bus services using adapted minibuses or cars. From the data available in the GHS it is not possible to estimate the market within this group for these two types of service, but from the point of view of the users, the way in which it is divided probably depends on two factors: the nature of people's disabilities, and their attitude to being treated as "special cases". Conventional cars and taxis are not yet wheelchair-accessible (although the next generation of taxis in the large towns of Great Britain will be), so special services with lift or ramp-equipped vehicles are the only alternative for the most severly disabled people in this group. Others benefit from the helpful, caring nature of the service provided by special transport schemes which they do not consider they would obtain from a taxi service. A survey of users of one special transport scheme showed that after cost, the main advantage of the service compared with taxis was that the staff were helpful and caring (Bowlby, Kirby and Swann, 1984). On the other hand, some disabled people probably welcome being treated as much as possible like able-bodied people, and would therefore prefer a subsidised taxi scheme to any form of transport provided specially for disabled people. If cost-effectiveness were to be the only criterion used to determine whether people in this group should be provided with subsidised taxis or special services, all but those who were physically unable to use taxis would be provided with a subsidised taxi service. Research on the operations of one scheme, Readibus, included theoretical comparisons between these two types of provision and showed that for the same net cost, a subsidised taxi service can provide far more journeys for disabled people than a special transport scheme (Heraty, 1984). The research on Readibus also enables some estimates to be made of the way in which the market for alternative services might be divided if this criterion were used; the scheme was open to anyone who was unable to use public transport, and one-fifth of the users were in wheelchairs (Heraty, 1984). Since half of the people in the GHS with difficulties on buses and getting to the bus stop were bus users, they would almost certainly be able to use taxis. If the remaining half were like Readibus users, a tenth of the entire group (or 0.25 percent of people agsd 16 and over) would require special transport for people in wheelchairs, and the remainder (2.25 percent of people over 16) would be able to use subsidised taxi services.

The people with difficulty reaching bus stops and on buses were older than those in the other groups, and less likely to be working; almost all suffered from a long-standing illness or disability. It is likely therefore that their travel requirements would be rather different from those of other groups.

The other group for whom some form of alternative to conventional public transport might be beneficial is the people with difficulty getting to the bus stop and with no other problem, and those who also had difficulty waiting at bus stops; these comprised 1.2 percent of the population over 16 in the GHS. For these people, three types of solution are possible, although one is probably impractical. Feeder bus services taking disabled people from their homes to the main bus network is one solution. The advantage to the users is that they can wait a home or in the feeder bus, rather than at the bus stop, and the amount of walking is reduced. For the operator, the amount of mileage without any passsngers on board is likely to be lower than on special services, while patronage on the main network would probably be increased because about a third of the people in this group were not bus users, due to the dificulties they experienced in reaching bus stops. Another alternative would be to provide denser networks of conventional bus services, presumably at reduced frequency. This would involve disbenefits to other users, although it is likely that some other passengers would benefit from the decrease in walking distance. Evidence from the British National Travel Survey suggests that shorter distance to bus stops are associated with more frequent use of buses at all levels of service frequency, both among the whole population and elderly. Howeve, research on service elasticities suggests that in the population as a whole, frequency of bus travel is more sensitive to differences in frequency of service than to differences in route density (TRRL, 1980); there is no evidence to suggest whether this is the case for elderly and disabled people, but the reverse could well be true. It is likely therefore that denser route networks with less frequent bus services would be associated with a decrease in bus patronage and net disbenefits to other passengers. The third solution for this group is to include them in the group qualifying for special transport or subsidised taxes. Such transport is more difficult to justify in this case, since only one-third were prevented from using buses by this problem (compared to half of the people in the other group). The decision on whether to provide feeder buses or special services for this group would

TABLE 11

Frequency of bus travel, age and physical difficulty

Percentage of bus users

	Age and health difficulty								All ages	
	16–29		30–64		65–74		75+			
	Difficulty	None	Difficulty	None	Difficulty	None	Difficulty	None	Difficulty	None
5+ days a week	34	28	18	19	13	15	7	14	15	21
1–4 days a week	28	35	43	36	53	56	58	55	48	39
Once or twice a month	19	16	15	16	15	14	16	16	16	16
Less often, but in last 6 months	19	20	24	29	19	14	20	15	21	24
Number of respondents	79	3514	481	5598	349	1367	290	586	1199	11065

Source: 1982 GHS

probably depend on whether local policy favoured providing a variety of different transport schemes meeting disabled people's needs as cost-effectively as possible, or fewer types of scheme for organisational simplicity, accepting that some people were not being provided with the cheapest possible service to suit their disability.

4. *Future Changes*

The population structure of the UK is changing, and over the next 20 years or so there will be an increase in the number of very old people; between 1981 and 2001, the population over 75 will increase by an eighth (Central Statistical Office, 1983). If the rates of incidence of difficulties with bus travel remained the same in each age and sex group between 1982 and 2001, this change in population structure would means an increase of 3.9 percent in the number of people over 16 with diffculty using buses, and of 4.4 percent in the number over 65 with such difficulty. This indicates that the problem is likely to increase in scale to a small extent if improvements to bus services to suit the needs of disabled people are not implemented over the country as a whole. However, this figure cannot be used as a basis for estimating the size of the future population of people with difficulties because it takes no account of any change in the nature of the bus service provided over the next 20 years. Such changes could be dramatic after the introduction of the proposed legislation for deregulation of the bus industry, and it is not yet clear what effect the operation of the free market is likely to have on the provision of special services or the improvement of vehicle design to accommodate the needs of elderly and disabled people. Similarly, it is not clear what effect deregulation will have on the decline in level of bus service provision, but changes in levels of service could have substantial effects on the proportion of people with difficulty using buses.

Travel Demand

It has already been noted that 18 percent of bus journeys in Great Britain are made by people over pensionable age, and by applying rates of reporting difficulties with bus travel among bus users in the GHS to National Travel Survey data, it can be estimated that 9 percent of all bus journeys are made by people with difficulty using buses. The potential demand for travel on buses or alternatives to conventional public transport is difficult to estimate because evidence on current levels of travel is very fragmented, and the extent of unmet demand for new services among a group of people who have generally become accustomed to a very low level of mobility, is almost impossible to assess. This section will briefly review the available evidence on the use made of special transport services and conventional bus services

TABLE 12

Frequency of bus use among estimated market for various improvements in bus service

Difficulties with bus use	Bus users — per cent using buses				% who were non-users (estimate)	Number of respondents (estimate)
	5+ days a week	1–4 days a week	Once or twice a month	Less often, but in last 6 months		
1. Getting on or off the bus only	15	54	15	15	16	407
2. Getting to or from the seat only or getting to or from the seat and getting on or off the bus	18	55	10	18	22	122
3. Waiting at the bus stop only	14	51	11	24	18	45
4. Getting to the bus stop only or getting to the bus stop and waiting	12	50	20	19	32	232
5. On-vehicle and bus stop	11	48	16	25	50	486

Source: 1982 GHS

by disabled people, to provide some indications of the minimum level of demand for such transport.

1. Effects of Difficulties on Frequency of Bus Travel

The number of bus users in the GHS was clearly affected by health difficulties, since 2 percent of all respondents reported that the only reason why they did not use buses was the physical difficulty involved. Among bus users in general, frequency of bus use appeared to be slightly affected by health difficulties but elderly bus users travelled rather less frequently by bus if they had difficulties than if they did not, while younger people used buses more often if they had difficulty (see Table 11). A possible explanation for this difference is that because the majority of people with difficulty using buses had a limiting long-standing illness or disability, they probably also had difficulty using other modes of transport and for younger people this may have meant travelling more by bus rather than using other more difficult modes, whereas elderly people may have avoided travelling rather than face the problems of bus travel.

One way to assess the scale of the effect of physical difficulties on frequency of bus use is to estimate the number of extra bus journeys which might be made if all such difficulties could be overcome Because health difficulty among bus users as a whole was not associated with a marked decrease in frequency of bus travel, most of the increase would probably occur as non-users whose sole reason for not using buses was the physical difficulty involved, began to use buses. If people with difficulty could travel by bus as often as others of the same age and sex, bus journeys would probably increase by around 4 or 5 percent.

Some combinations of difficulties appear to have had a greater effect on frequency of bus travel than others. It has already been noted that the proportion of bus users in the potential market for different types of improvement in service varied, and among bus users, there was also some variation. Table 12 shows that people with difficulty getting to bus stops (whether or not they had other difficulties) were less frequent bus users than those with other difficulties, while the three groups forming the market for modifications to conventional services did not use buses much less often than those without difficulty shown in Table 11, except that the latter group were more likely to use buses on 5 or more days a week, presumably because a larger proportion were working. It is therefore likely that modifications to conventional service would be associated with a small increase in bus travel. People provided with alternative special transport could potentially increase their frequency of travel to a much greater extent, although their use of conventional services would probably decrease. A survey of users of one special transport scheme found that many of the journeys had previously been made by bus but many had not previously been made at all (Bowlby, Kirby and Swann, 1984).

2. Use of Special Transport Schemes

Research for TRRL on the use of special transport schemes is in progress at the Transport Studies Unit, Oxford University at the moment. Preliminary results and studies in other areas suggest that the average number of journeys per member is of the order of 0.75 to 2 journeys per month on two demand-responsive services with adapted vehicles (Islington Dial-a-Ride and Readibus), and two user-side subsidy schemes based on taxis (Southwark and Edinburgh Cripple Aid Society) (Bailey and Appleby, 1983; Heraty and Fowler, 1982; Foulkes and Howard, 1983). A longer-established user-side subsidy scheme in Stockholm, in which the number of journeys users could make on the taxis was restricted to 72 per year (although they could apply for more), passengers made an average of 5—6 journeys per month (Rihani, 1982). In 1976 it was reported that on average about half the permitted maximum number of trips were made. (Morris, 1976).

It is difficult to assess the potential demand from these figures because dial-a-ride services tend to be constrained in the capacity they can provide, while the costs involved in paying the passenger's contribution to taxi fares on a user-side subsidy scheme may also constrain demand in this low income group. Some idea of the level of unmet requests for journeys can be obtained from the survey of Readibus where a third of users reported journeys that they had been unable to make on the service (Bowlby, Kirby and Swann, 1984.

Use by individual members appears to be extremely variable. For example, on Readibus 25 percent of the journeys were made by only 8 percent of the passengers. For some users, Readibus quickly became their main means of transport whereas for others it was used occasionally sometimes as a back-up when other means were not available (Bowlby, Kirby and Swann, 1984). Although average use may be low, because disabled people generally have a low level of mobility, journeys on special transport can still comprise a large proportion of their journeys; for example a third of all journeys by Readibus users in the previous week had been made on the Readibus service (Bowlby, Kirby and Swann, 1984).

Rapid growth in the number of journeys made on special and modified transport has been observed in most schemes, at least in the first few years (see for example Bailey and Appleby, 1983; Bowlby, Kirby and Swann, 1984; Oxley, 1984b). However evidence from two special schemes (Readibus and Edinburgh Cripple Aid Society) suggests that the number of users increases at the same rate, so the number of journeys made by each user does not increase. Given sufficient time and an unconstrained capacity in the service, use would probably increase substantially; it is however unlikely in the short term to increase to the frequency of travel by able-bodied people, because many disabled people are elderly, they tend to have low expectations, and to have adapted their style of life to suit a very low level of mobility.

The implication of this is that in the short-term at least, it should be possible to predict the approximate level of use that will be made of any given special or modified transport scheme in Great Britain (even if it is not possible to predict the potential demand). The incidence of transport disabilities among the population in the local area (which can be estimated from age-specific rates of reporting difficulties in the GHS), combined with the date on the use of other similar transport schemes already in operation which in now becoming available, will probably provide a resonable basis for making such estimates.

Summary and Conslusions

Travelling by bus involves a number of physically demanding tasks which represent considerable barriers to disabled people, but such people form a significant portion of the market for bus travel. Ten percent of people over 16 in Great Britain experience physical difficulties using buses, and 8.3 percent have been identified as forming the main market for improvements in public transport to suit elderly and handicapped people, because they are bus users or people whose only reason for not using buses is the physical difficulty involved. People with difficulty using buses are more likely to suffer from other disadvantages affecting travel; for example they have lower levels of car ownership and economic activity than people of the same age without difficulty using buses.

Preliminary analysis suggests that for a third of these people, these problems could be overcome if modifications to the design of conventional buses of the type that are now being made in some areas became widespread, improving entry and exit designs and making it easier for disabled people to move around inside buses. For another third with difficulty reaching bus stops and on buses, special door-to-door services are probably the most cost-effective solution since half are unable to use local bus services and the remainder appear to use them less frequently because of the difficulties involved. The requirements of this group are also likely to differ, since almost all had some long-standing illness or disability. Within this group, a small minority would require special transport for people in wheelchairs but other door-to-door services would be adequate for the majority. The remaining people, with difficulties reaching bus stops but not difficulties on the vehicles, could be provided with feeder bus services or special door-to-door services.

A wide variety of special transport is now available in Great Britain, and evidence on the most cost-effective types of provision which best meets people's travel requirements is now being collected. However, financial constraints may mean that it will not be possible to continue subsidising the whole range of different types of scheme, and decisions will have to be made on the best balance between different types of service. The evidence on the size of the market for different types of transport suggests that a combination of modified conventional services, subsidised taxi services and special vehicles providing a door-to-door service for people who cannot use taxis or modified conventional service will be the most cost-effective solution. All of this assumes conventional transport used by able-bodied people is accessible to over half of the people forming the main market for special services. This ignores the question of the most satisfactory balance of service for meeting people's travel requirements, but it is hoped that this will be answered by research in progress.

In sum, this paper has shown that demand for travel on these schemes is at present difficult to estimate. The use made of them by disabled people is very low and at least in the short term, does not appear to increase very much as people adapt their travel patterns to the new opportunities available; growth in use appears to occur as the number of users of schemes increases. Thus in the short-term, travel demand can be predicted on the basis of the size of the market and use of existing schemes, which appears to be at a rate of 1—2 journeys per month on average. In the long term, however, as expectations rise and new generations of disabled people enter the market, travel demand by disabled people must surely increase as it has in Sweden. The size of the market may also change as the nature and level of bus service provision changes following deregulation, although the likely effect is at present difficult to predict.

Acknowledgements

The assistance of Eileen Goddard and others in the Social Survey Division, Office of Population Censuses and Surveys in providing tabulations from the General Household survey is gratefully acknowledged. The work described in this paper forms part of the programme of the Transport and Road Research Laboratory. The paper is published by permission of the Director.

References

Appleby, Lynda (1983). Directory of special transport services for disabled people in Great Britain. Oxford University, Transport Studies Unit, 240/WP.

Bailey, John and Appley, Lynda (1983). Recent developments in special transport for disabled people. Oxford University, Transport Studies Unit, 239/WP.

Bailey, J (1984). Underlying factors in the development of demand-responsive transport in Britain. Paper presented at Third International Conference on Mobility and Transport for Elderly and Handicapped Persons, Orlando, Florida.

Bowlby, S R, Kirby, A M and Swann, V (1984). Use of demand-responsive transport for disabled people: the Readibus example. TRRL Report (forthcoming), Crowthorne.

Brooks, B M, Ruffell-Smith, H P and Ward, Joan S (1974). An investigation of factors affecting the use of buses by both elderly and ambulant disabled persons. British Leyland Truck and Bus Division. Leyland and TRRL.

Brooks, B M, Edwards, H M, Fraser, C R and Levis, J A (1980). Passenger problems on moving buses. Department of the Environment, Department of Transport, TRRL Report SR 520. Transport and Road Research Laboratory, Crowthorne.

Central Statistical Office (1983). Social Trends 13, Table 1.2 H M Stationery Office, London.

Department of Transport (1982). Door to door: a guide to transport for disabled people. H M Stationery Office, London.

Department of Transport (1983). National Travel Survey: 1978/9 Report. H M Stationery Office, London.

Feeney, R J, Ashford, N J, Morris, A and Gazely, D (1979). Travel and the handicapped: a project summary. Department of the Environment, Department of Transport, TRRL Report SR 480. Transport and Road Research Laboratory, Crowthorne.

Foulkes, M and Howard, B (1973). A need based approach to transport planning: a strategic planning view. Paper presented to Conference on A Needs-based Approach to Transport Planning, Camden.

Harris, A I (1971). Handicapped and impaired in Great Britain. Office of Population Censuses and Surveys, Social Survey Division. H M Stationery Office, London.

Heraty, M (1984). Monitoring demand-responsive transport for disabled people: the Readibus example. Department of the Environment, Department of Transport, TRRL Report SR 828. Transport and Road Research Laboratory, Crowthorne.

Hillman, M, Henderson, I and Whalley, A (1976). Transport realities and planning policy. PEP Broadsheet 567. Political and Economic Planning, London.

Hopkin, Jean M (1981). The ownership and use of cars by elderly people. Department of the Environment, Department of Transport, TRRL Report LR 969. Transport and Road Research Laboratory, Crowthorne.

Hopkin, Jean M (1984). Changes in bus travel by pensioners following a reduction in the local fares concession. Department of the Environment, Department of Transport, TRRL Working Paper H&SF 13. Transport and Road Research Laboratory, Crowthorne.

Hopkin, Jean M, Robson, P and Town, S W (1978). The mobility of old people: a survey in Guildford. Department of the Environment, Department of Transport, TRRL Report LR 850. Transport and Road Research Laboratory, Crowthorne.

Mitchell, C G B (1980). The use of local bus services. Department of the Environment, Department of Transport, TRRL Report LR 923. Transport and Road Research Laboratory, Crowthorne.

Morris, A (1976). Report of a study tour in Sweden. Institute for Consumer Ergonomics, Department of Transport Technology, Travel and the handicapped report No. 3. Loughborough University of Technology.

Morris, A and Gazely, D (1977). A study of physically handicapped travellers in Coventry. Institute for Consumer Ergonomics, Department of Transport Technology, Travel and the handicapped report No.6. Loughborough University of Technology.

Office of Population Censuses and Surveys, Social Survey Division (1984). General Household Survey 1982. H M Stationery Office, London.

Oxley, P R and Benwell, M (1983). The use of buses in Sheffield by elderly and handicapped people. Department of the Environment, Department of Transport, TRRL Report SR 779. Transport and Road Research Laboratory, Crowthorne.

Oxley, P R (1984a). Adaptations to stage carriage buses for disabled and elderly persons. Paper presented at Third International Conference on Mobility and Transport for Elderly and Handicapped Persons, Orlando, Florida.

Oxley, P R (1984b). Study of bus services for wheelchair-bound people. TRRL Report (forthcoming), Crowthorne.

Rihani, S (1982). The disabled and elderly: a passenger transport prespective. Merseyside Passenger Transport Executive, Liverpool.

Taylor, J (1982) Profile 4, Community Transport Quarterly, 1,4 December.

Transport and Road Research Laboratory (1980). The demand for public transport. Transport and Road Research Laboratory, Crowthorne.

(C) Crown Copyright. Any views expressed in this paper are not necessarily those of the Department of the Environment or of the Department of the Environment or of the Department of Transport. Extracts from the text may be reproduced, except for commercial purposes, provided the source is acknowledged.

Jean Hopkin, Higher Scientific Officer, Human and Social Factors Division, Department of the Environment, Transport and Road Research Laboratory, Crowthorne, Berks, England RG11 6AU.

DEVELOPMENT OF AN EVALUATION METHODOLOGY FOR STATE AGENCIES FUNDING ELDERLY AND DISABLED TRANSPORTATION PROGRAMS: A COORDINATED APPROACH

Kenny Hosen

Introduction

Government agencies funding elderly and disabled transportation programs are required to be accountable for the funds they allocate. How this is accomplished is generally left up to each individual state agency. There are a number of ways that these agencies can demonstrate accountability but it is usually determined by fiscal and/or program evaluations/reviews.

State funding agencies, in order to ensure accountability, often require considerably more information of transportation providers than is needed to perform an evaluation or audit. Providers with multiple funding sources often have conflicting or duplicative service requirements. This results in higher overall costs for transportation providers and funding agencies. A coordinated evaluation can change this and may be the best way to get funding agencies more involved in improving the overall service, not just for their client group. Funding agencies will be able to assess their own collective administration of the provider, correct deficiencies and resolve conflicts between each other. This is something that the transportation operators are doing in most states, rather than the funding agencies. Providers are coordinating as much as possible, but alone they can only do so much.

Funding agency coordination should start with an evaluation. Problems cannot be corrected until they are recognized and understood by all concerned. A coordinated evaluation can accomplish this and pave the way for expanded administrative coordination among state agencies.

This paper will open with a discussion of accountability, then focus on the role of government in accountability and what is required by each state and federal funding agency. The paper will close with a discussion on a coordinated approach toward the evaluation of funding agencies' collective administration of elderly and disabled transportation services.

Accountability

Typically, elderly and disabled transportation as well as rural public transportation systems (when they have multiple funding sources) as in the case of Texas, have to comply with up to four different sets of record keeping and accountability requirements. Compounding the problem of multiple record keeping and accountability requirements is the level and amount of information sought by various state and local funding agencies. Some agencies insist on information and documentation of rural public systems that is far in excess of what any other form of public transport is required to report. Rural public transportation systems must often verify client eligibility and ensure that clients are going to an eligible service, often including several long distance phone calls.

What is accountability? At what point are the reporting requirements of funding agencies a legitimate need and at what point are they a waste of time and money? In addition, the more information a funding agency requires, the greater chance that providers may view all data requirements as superfluous, thus minimizing the importance of it and reducing the accuracy of the data collected and reported. In other words, they make it up.[1]

Accountability, then, is the demonstration of proper use of funds given by one agency to another for the purpose of providing a service. Is the service provided at a reasonable cost and are the funds being spent as required?

The record keeping and accountability functions required by funding agencies revolve around three basic needs. These needs are:

1. *Program Accountability*. The procedures used to verify that the service was provided and that it was delivered to an eligible individual. This could be anything from reporting simply the number of trips taken by elderly persons to the reporting of names, destination and purpose for each trip.

2. *Cost Allocation*. Funding agencies must make sure that they are not supporting a service that is more expensive than they could obtain elsewhere.

3. *Service Accountability*. Funding agencies must evaluate the quality of the service provided to ensure that services are delivered as specified in the contract or grant.

---

[1] In discussion with operators from Texas there were several indications that data was not adequately verified prior to reporting. Most of these operators had a human service orientation.

Human service funding agencies generally have a different perspective than transportation funders regarding accountability. State human service agencies are interested in each client's usability of the system. State transportation agencies are more concerned with various efficiency indicators. An Office of Human Development Services publication states the differences very well. "The essential difference between public transit and social service transportation is the concern with an individual's trip."[2] This difference should be reflected in what each agency evaluates.

Government's Role

The Reagan administration has brought a new focus to Federal involvement in a multitude of programs. Nowhere is this more evident than in transportation. In elderly and disabled transportation programs, as well as rural public transportation, the state and local entities have been given almost full control in developing policy. Clearly it is up to the states to seize the moment and develop policy and procedures that will be effective.

There are a number of approaches that a state can take toward promoting service delivery. These fall into three categories.

1. *Fragmented*—Where there are no formal (but there may be informal) cooperative/coordination agreements among state agencies, each state agency runs its own program usually independent from other agencies. Texas is an example of this approach.

2. *Cooperative*—This approach is found in states where there is a formal working agreement among the agencies involved to coordinate services. This is usually developed through a non-binding inter-agency agreement. Massachusetts and Arkansas are typical examples of this type of approach.

3. *Coordinated*—In states where there is enabling legislation or an executive order mandating coordination, services are typically coordinated through a local council of agencies with one state agency serving as lead. Examples of this approach are South Carolina and Michigan.[3]

Any of the three approaches can produce coordination among state agencies. It does appear that the cooperative and coordinated approaches may better lend themselves to agreement. This paper will not, however, recommend one framework over the other. The primary objective here is to simply review recent pertinent developments.

State Agency Accountability

There are five federal programs that fund the majority of transportation services for the elderly and disabled in Texas. Three state agencies administer the programs and two federal Departments, Transportation and Health and Human services (DOT and D/HHS) oversee them. The five programs each have a large degree of state and local control. Following is a description of the accountability requirements of the five programs at each level of government.

1. Section 16(b)2 of the Urban Mass Transportation Act. This program funds capital acquisitions. The Urban Mass Transportation Administration (UMTA) Section 16(b)2 Capital Assistance Program Guidance Circular states that:

> . . . the State agency is expected to certify eligibility of applicants and project activities, review applications, select projects for approval, ensure compliance with Federal requirements, monitor local projects and oversee project audit and closeout.[4]

There are no specific monitoring and evaluation guidelines from the federal level.

The Texas State Department of Highways and Public Transportation (SDHPT) administers the section 16(b)2 program in Texas. Since Section 16(b)2 is a capital acquisition program there is very little monitoring and evaluation performed. The SDHPT district offices, of which there are 25 in the state, perform the accountabiilty functions. These consist of monitoring monthly reports (designed at the state level) for utilization by the appropriate client groups (elderly or disabled), routine maintenance and insurance. This district contact person also makes at least one field visit per year.

2. Section 18 of the Urban Mass Transportation Act. UMTA has basically the same policy regarding accountability in Section 18 as in Section 16(b)2: little or no involvement in day to day administration of the programs. The states are to be responsible and certify that the projects are meeting the statutory and administrative requirements for project approval.

The SDHPT administers this program. There are no written procedures at the state level regarding Section 18. The District office is responsible for monitoring and evaluation. This consists of monitoring reports (also designed at the state level) and looking into any problems revealed through the monitoring.

3. *Title XIX of the Social Security Act*. Title XIX provides funds for medical transportation of Medicaid recipients. The Department of Health and Human Services

---

[2] Office of Human Development Services, HDS Transportation Initiative: A Report on Research Findings. 1981, pg. 22.

[3] The Transportation Accounting Consortium report, Simplifying Human Service Transportation and Small Transit System Accounting, 1983, surveyed the accounting and reporting practices of member states. It gives excellent examples of the types of coordination approaches states can take.

[4] Urban Mass Transportation Administration, Circular—Section 16(b)(2) Capital Assistance Program Guidance. 1983, 1-3.

administers the program at the Federal level. Title XIX is a medical services program, consequently Title XIX transportation tends to be treated as a medical-related service. Accountability requirements are similar to medical programs in that detailed information is required for each trip. The state does, however, have an option to accept a lower match rate (usually no more than 5 percent lower), which would eliminate the detailed accountability requirements.

The Texas Department of Human Resources (TDHR) administers the Title XIX Medical Transportation Program in Texas. The State, in attempting to address the extensive accountability requirements has developed a set of standards. These standards revolve around verification of client eligibility, denial of trip, on time performance and changing of scheduled departure time. Its intent is to:

> . . . reveal the quality of contracted transportation services for eligible clients to medical services and divulge the quantity of contracted transportation services received by ineligible individuals.[3]

At the regional level, each region directs its own program. Some have additional accountability requirements, while others do not.

4. *Title XX of the Social Security Act.* Title XX is a federal block grant with no specific accountability requirements for transportation from the federal level. In Texas, transportation is not a direct service. At times it is built into an individual contract as a support service. As a result of this, there are no accountability requirements at the state level targeted for transportation. Due to the fragmented nature of transportation in the Texas Title XX program very few coordinated transportation systems utilize Title XX funds.

5. *Title III of the Older Americans Act.* The U.S. Administration on Aging in the Department of Health and Human Services administers the Title III Nutrition services and Area Planning and Social Services Program. There are no specific accountability requirements for transportation other than the state unit or agencies being accountable for monitoring the program. The Texas Department on Aging (TDOA) also has no specific accountability requirements other than requiring information on unduplicated trips by various categories.

The local area agencies on aging (AAA) administer the funds at the local level. It is here that specific accountability requirements are developed for operators to follow. One AAA in Central Texas performs an extensive evaluation. This includes field observation (talking to users and examining equipment) and a full examination of records (logs, financial statements and contribution lists). Another AAA performs field visits and does a cursory review of records without getting into details. A yearly public hearing is held so that board members can determine where to allocate funds. A third agency does nothing more than field visits. As can be seen, evaluation of Title III transportation is up to each local AAA.

Developing a Coordinated Approach

The preceding section demonstrates that each state agency has its own accountability requirements which are usually not in writing. As a result, each agency works independently even when dealing with the same transportation operator.

This does not have to be the case. Because there are very few restrictions from the federal level, each state agency can make significant changes in their program, especially if it will improve services.

In developing a coordinated approach to service delivery the first step is to open a dialogue between the various funding agencies at the state and local level and the transportation providers. After all, these entities are in business together and it is in everyone's best interest to talk. The purpose of this is to look at how to coordinate state and local administrative and operational functions. The first step in the coordinated approach is the evaluation.

Evaluation can be an excellent coordination tool. It can initiate the coordination process by measuring and analyzing the effectiveness of the state agencies' collective administration of a program and identify deficiencies. This can provide an excellent starting point for a coordinated effort. An evaluation can also do the following:

1. Provide a more intensive and complete review.
2. Eliminate time and money expended by funding agencies and transportation providers on administering the evaluation process.
3. Streamline the recordkeeping process.
4. Create less of an imposition on the transportation provider by requiring a single evaluation document rather than three to six sets of evaluations.
5. Produce a document that the provider can use as a tool to improve the service.
6. Develop a corrective action plan agreed upon by all interested agencies.
7. Increase the possibility that this could lead to other cooperative efforts.

Once the agencies and providers meet they can begin to compile their collective goals and procedures into a workable evaluation plan. This plan consists of three major components:

---

[3] Texas Department of Human Resources, Draft Medical Transportation Handbook, June 1984.

a) selection of criteria,

b) assessment of attainment of criteria, and

c) utilization of results.

These three components are described below.

1. *Selection of Criteria*. The state agencies and transportation provider must be evaluated based on a set of criteria or standards. The standards can be based on the outputs of its own program over time, to similar systems and/or to standards set by funding agencies.

Initially, funding agencies have to determine what is important enough to be measured. After this has been determined, the development of a standard and a method of measurement is required. Not all standards will be easily measurable, though, as Rosenbloom points out:

> . . . Everyone wants clean vehicles, helpful drivers and safe operations. But you must decide how these service factors will be measured and you must set minimum levels of acceptable service; vehicles can't always be clean and accidents happen occasionally. How clean is clean? How safe is safe?[6]

Many times these sorts of subjective standards can only be measured in general terms. Just because they cannot be quanitified, does not mean they are not important. Subjective standards do have merit as long as they are measured consistently throughout a program.

It is at this point that funding agencies must realize that, in evaluating the overall program, they are evaluating themselves and how their collective administration is affecting the program. Therefore, funding agencies must develop standards to measure their own performance separately and collectively. For example, are the record keeping requirements placed on operators duplicative, excessive or conflicting?

2. *Assessment of Attainment*. This step requires the use of monitoring and inquiry to determine how well the criteria have been met. Once the standards to be utilized are established the next step is to determine the method of data collection requried to measure the standards. For elderly and disabled transportation, data can be collected by funding agencies through four means:

a) *Field observation*
b) *Surveys*
c) *Public hearings*
d) *Examination of records*.

These are described as follows:

a. *Field observation*. Field observation includes inspections of provider facilities' personnel and equipment, both on a formal and informal (spot inspection) basis. This form of monitoring is essential for evaluating service accountability. One advantage to this coordinated evaluation is that only one agency needs to perform this function; information is to be shared with other funding agencies.

b. *Surveys*. There are service accountability needs that cannot be monitored through field visits. Accountability needs of human service funders include checking the on-time performance of the system as well as driver and intake courtesy. Public transportation funders are interested in user attitudes and habits. These are needs that can be monitored through the use of surveys.

Surveys can be made of users, case workers (of human service agencies) and/or advocates of particular client groups. Client surveys do, however, have a number of flaws limiting their credibility except in support of other data: they can be extremely costly to perform, and the accuracy of responses can easily be questioned.

Useful information can be gathered in a survey if it is carefully designed. It is recommended that client surveys not be used alone as an evaluation tool due to the flaws, but when combined with other data collection methods they can be very helpful in identifying problems.

c. *Public Hearings*. Public hearings can be used in a way similar to surveys: to solicit input from the public on the quality of the program. As in surveys, public hearings also have flaws. One difficulty with public hearings is that organizations wanting to make a point can generate large numbers of persons to testify for that organization, while those with opposing viewpoints who may not have transportation available and their voices are not heard in the process. In addition, dissatisfied users that depend on the service are not likely to testify openly against that service for fear of reprisal. As in surveys, data collected from public hearings must be taken with a "grain of salt," although, when combined with other methods, hearings can be helpful.

d. *Examination of Records*. Another important component of monitoring is the examination of records. Public transit funds can examine performance and productivity measures while human service agencies can examine client and trip purpose eligibility indicators (program accountability) and cost allocation needs. Service accountability functions, such as examining agency insurance and training records, would also be performed.

While some agencies are attempting to get away from excessive paperwork others are still adding on new requirements. The major problem with additional paperwork is cost. Time and effort expended in recordkeeping is time and effort taken away from the provision of service. A good starting point for any state would be to look at the work completed by the Transportation Accounting Consortium, which has performed an extensive study of record keeping needs and approaches to meeting those needs.[7]

---

[6] Rosenbloom, Sandra. How to Make Your Transportation System More Efficient and Effective. Urban Mass Transportation Administration. 1981, pg. 21.

Financial audits are included in the examination of records. There have been some experiments in the single audit concept, where one audit is performed for a transportation provider's entire program. Since program staff have little control over audit staff, this kind of coordination would require a close working agreement among all state agencies involved.

3. *Utilization of Results.* While not intrinsic to the process of evaluation, unless a direct attempt is made to link evaluation data to the decision making process, the impact of the findings will be minimal. In other words, if one is to go through the time and effort to evaluate a program, one should use the results to correct deficiencies.

Wherever deficiencies are noted a corrective action plan should be developed. The plan should be put together in a coordinated setting by the various funding agencies and the transportation provider. Without consent from each entity the plan will be destined to fail. The key to this approach is to assure that agencies are not working at cross purposes. This must be clearly understood in the formation of criteria component.

Once the evaluation is completed the funding agencies and the operator will have a clear picture of service delivery and administration. This is the starting point for negotiating to improve the service.

Summary

What can state funding agencies do to improve transportation of the elderly and disabled? The first necessary step is a pledge to work together. Transportation providers often complain of conflicting requirements in both operations and administration that emanate from the state level. This paper contends that a good way to initiate cooperation among funding agencies is to perform a coordinated evaluation of transportation services leading to the collective recognition of deficiencies in the program.

State agencies (at both the state and sub-state level) must get together and initiate a coordinating mechanism so that operators can have the flexibility to make necessary changes while still being accountable. This is where a coordinated evaluation can help initiate the process. State agencies must recognize that by helping the transit operator provide more efficient services, they are helping themselves and the client groups (or general public) they serve. It is essential to get operators out of the job of coordinating state agencies and back to transporting people.

Kenny Hosen, Transportation Planner, Texas Department of Human Resources, PO Box 15995, Austin, Texas 78761.

---

[7] The Transportation Accounting Consortium, Simplifying Human Service Transportation and Small Transit System Accounting 1983, Lansing, MI.

THE PROCESS OF SUCCESSFUL TRANSPORTATION CONTRACTING: CASE STUDIES AND RECOMMENDATIONS

Mary Hough and Ann Zeltmann

Introduction

Cities and human service agencies have, over the past few years, tried many approaches to providing transportation for elderly, handicapped, and rural citizens, including attempts to contract with private transportation providers for service. Such contractual arrangements have oftentimes provided benefits for both parties. Agencies and cities, which have neither the expertise nor the desire to be in the transportation business, have found they can achieve the same or better levels of service for less cost; have been able to retain some control over the availability of transportation service without the problem of running it; have found themselves in a more comfortable position working with, rather than competing with, private transportation providers; and in the case of agencies, once again have been able to concentrate their resources on their primary service. From the perspective of the private transportation provider, such contractual arrangements have removed what is viewed as unfair subsidized competition, and returned the responsibility for transportation service, along with the revenues, to those who have the ability to best provide the service.

Attempts by public entities to contract for transportation service in the private sector have produced widely varying results, with some notable successes and some disasters. Using a case-study method, this research examined the contractual processes used in four cities to provide public transportation through private providers. The purpose of the study was to determine what elements of the process produced success and what led to failure.

The case studies began with a survey conducted by the International Taxicab Association. The survey looked at programs in thirty cities where contracts between public transportation entities and either profit or not-for-profit transportation providers have been used. Most of the contract services surveyed provide transportation services for the elderly and handicapped. A few programs, however, offer transportation to the general public or rural transportation services. From the group of thirty, four programs were selected to be studied in depth. The selection of four allowed the opportunity to study the effects of a variety of elements on the contracting process: different program sizes; different city sizes; different political situations; different program designs; involvement of different types of transportation organizations. Most important, it allowed the opportunity to study programs which had achieved different degrees of success. The cities chosen were Lawrence, Massachusetts; Cleveland, Ohio; Hartford, Connecticut; and Portland, Oregon.

Of the four, the Community Responsive Transit (CRT) program in Cleveland has operated relatively smoothly from original idea conception to current program implementation. The TRANSFARE program in Lawrence is also operating smoothly now, but a number of political problems had to be overcome in setting it up. In contrast, Hartford's Dial-A-Ride Program and Portland's LIFT program were, at the time of our research in the Fall of 1981, still struggling to work out difficulties.

The following case studies describe how each of the four programs had evolved and how they were being operated at the time our study was conducted.

Lawrence, Massachusets: Transfare Program

Since 1978, the elderly and handicapped populations of Lawrence have had their transportation needs supplemented by the TRANSFARE program. The program works as follows. Eligible citizens purchase books of ride tickets, valued at $10.00 for $5.00 each. The tickets have a face value of 25 cents each, and may be used to pay for up to $2.50 of each taxi ride within the Lawrence service area (any excess must be paid for in cash). The tickets are accepted by all nine taxi operations in the city. For each TRANSFARE trip, the taxi driver logs the passenger's name, the trip origin and destination, and the time the trip is taken. Every two weeks, the taxi operators submit the logs, are reimbursed in arrears, for the face value of the tickets accepted.

The City of Lawrence initiated the idea of the TRANSFARE program and actively pursued grant money available through a Federal demonstration program. The city's effort was led by an appointed program director. The city had two major related goals for TRANSFARE: to ensure that the program's clients receive the same amount and quality of service as non-subsidized taxi riders while at the same time maintaining the market structure of Lawrence's taxi industry.

When the idea of the program was first raised, all the operators were skeptical of dealing with the city. They were concerned about promptness of payment by the City, and about having their accounts audited. The program director understood that for the program to be successful it had to have the full support of the operators; this strategy for achieving this support was to include the operators in the program development. He had many meetings with the operators during which he elicited their ideas on how the program could be structured and the contract written to counter any misgivings they had. A series of "what if" scenarios were discussed before the program and contract were adopted. In fact, the operators had a great deal of input in determining the form and content of the final contract.

Because of the nature of the program, no request for proposals (RFP) per se was necessary. As described above, the program was developed through negotiations between TRANSFARE and the operators. This open and personal communication resulted in the opportunity for all parties to express their concerns and desires throughout the program development stage. It produced a contract that is responsive to the needs of all parties. A bid process was not used and was not required because of the demonstration nature of the program and because the intention was to work within the structure of the existing taxicab industry and to include all companies that were interested in participating. In fact, all of the taxicab companies in Lawrence did elect to participate.

The contract is an eleven-page document containing ten sections. Topics include description of the program and the service area; termination procedure; operating procedures (including those for reimbursement); general obligations of the provider (including employee training, vehicle maintenance, accounting practices, reporting procedures, insurance requirements); records to be kept; and agency requirements.

At the time of the case-study, all of those concerned with the program—the clients, the operators, and the city—appeared satisfied with the program. There were about 4500 persons registered to use TRANSFARE, and the program was supplying approximately 10,000 rides per month.

Cleveland, Ohio: Community Responsive Transit

Community Responsive Transit (CRT) is a special program of the Greater Cleveland Regional Transit Authority (RTA) that serves the elderly and handicapped of the City of Cleveland and Cuyahoga County. The program service area covers 464 square miles and is divided into eighteen service districts. RTA supplies service to the seven districts in the Clevelend city limits, while the remaining eleven outlying districts are serviced by Yellow Cab Company of Cleveland under a three-year contract with RTA. Although the service is supplied by two distinct entities, operationally it is one program. Eligible citizens call the telephone number for their service area the day before they wish to make a trip. Every service district has its own local telephone number, but all calls are channeled to a centralized dispatching office at the CRT central office. The operators key information about the required trip into a computer which then develops routes for the following day. Routes for both the in-house and the contracted service are printed daily and distributed to the drivers. Persons can make trips for any reason, but are restricted to their service area.

The concept of contracting out elderly and handicapped services was present from the beginning, and because of this, RTA decided to involve a taxi operator in the design of the program. Preliminary research indicated that Yellow Cab was the largest of the cab companies in the Cleveland area and would thus likely be a future participant in the program. Thus, Yellow Cab was contacted for input into the design of the program, but with the knowledge that a competitive bid procedure would be used to award the contract.

Those most closely involved with the design of the program and its associated contract were RTA's Director of Transportation, RTA's Superintendent of CRT Operations, and the President of Yellow Cab of Cleveland. These three men met regularly between 1975 and 1976 and worked closely together to design a program that would best serve the elderly and handicapped of the region. They discussed various sizes and shapes of service areas to decide on the most logical, and decided that the program as it is currently structured was the best way to coordinate service efficiently and effectively. They also worked together to gain the confidence and necessary support of 350 social service agencies, and their clients, in the Cleveland area.

On 1 July 1976, RTA put out an RFP for one-third of the CRT program. This RFP was designed to be the major element of the final contract. It contained thirty-six topics, including requirements of bidders; tax requirements; insurance requirements; specifications (including the number and type of vehicles required, a description of the service required, required maintenance, and a description of those eligible for the service and the requirement that eligibility be checked); reporting procedures; contract duration; and other requirements. All topics were covered in ten pages of clear, easy-to-understand language. Bids were due by 1 September 1976 so that service could begin on 1 October. Although three bids were received, only Yellow Cab was actually capable of performing the service described in the RFP. The actual contract between RTA and Yellow Cab is a single sheet of paper stating that for three years, Yellow Cab will perform the services stated in an Addendum (the RFP) for the bid price.

At the present time the parties to the contract note that the business relationship is characterized by a high level of cooperation and open communication, mutual trust, and a contractual relationship that is more like a partnership than a hierarchy. Both parties also agree that the terms of the contract, while important, are not so rigid that variations cannot be tolerated. Acceptance of this flexibility has allowed aspects of the program to be changed, for the better, without disruption of service to renegotiate the contract.

At the time of the case-study, there were no major changes planned for the program and its funding sources were relatively secure. The only apparent problem was a lack of vehicles to meet the demand for trips, but neither this problem nor its solution were seen to be related to the contract. The program was handling about 32,000 rides per month, offering service to approximately 16,000 people.

Hartford, Connecticut: Dial-a-Ride

Hartford'a Dial-A-Ride program is a transportation program for the elderly and handicapped. The current program had its origins in a Model Cities program. Under Model Cities, Hartford provided each area of the city with a vehicle to be used to provide transportation for the elderly and handicapped. Under this program, service was uncoordinated, very inefficient, and many of the vehicles were not well maintained. In 1972, the city moved toward both consolidating service, and getting out of the transportation business. It was felt that less expensive and more flexible service could be obtained in the private market.

Personnel changes since 1972 prevented determining how the program was originally designed or how Yellow Cab of Hartford happened to be awarded the first contract. In any case, a contract was drawn up between Yellow Cab and the City of Hartford to provide transportation for the elderly and handicapped, using the vehicles which were inherited from the Model Cities program. The contract ran for only one year, but permitted annual renewal for four subsequent years. The actual costs of the contract were to be renegotiated annually based on changing operating costs. The program was re-bid and a new contract rewritten in 1976 and again in 1981, although both of these versions left the program structurally unchanged with Yellow Cab as the service provider.

Despite the long association between the city and Yellow Cab, relationships between the two were not good. Since its inception in 1972, five different people have run the program for the city, with some turnover in key personnel. For example, at Yellow Cab, the current owner took over about three years ago. This is, in fact, the source of some problems. Both parties are functioning within an historical framework which neither of them designed and which neither of them liked.

The program is structured so that the city provides the vehicles, gasoline, maintenance, and office space for operation of the program. The contractor is responsible for back-up vehicles; providing heated garage facilities for the vehicles; hiring and supervising drivers and operations staff; certifying eligible clients; and purchasing insurance coverage. Thus the program is very much a shared enterprise in spite of the fact that it is contracted to a private provider, and the city originally did not want to be in the transportation business.

The city uses a formal advertising bid process and awards the contract to the provider who offers the lowest cost per trip. Interested bidders receive a package of materials which includes (1) general specifications for the contract; and (2) special instructions which outline in extreme detail how the program is to be operated. The second package of instructions is a direct product of the deteriorating relationship between the city and Yellow Cab and essentially represents an attempt by the city to have more control over the contractor.

From the perspective of Yellow Cab, the major problem with the program is that moving people in vans is an expensive, inefficient method of transportation. They would prefer the use of shared-ride taxicabs. They feel the city does not understand the company's basic motive of profit, and find the constraints imposed frustrating. Beyond this, the cab owner believes the bid process prevents him from developing the quality or depth of experience that he would like to have in his staff. In order to bid low, salaries must be kept low. This acts to deter his best staff from remaining with the company for very long.

The city's major complaint about the program is that there have been a series of problems which have given the program a bad image. Most of the problems involve reliability of the service and insensitivity of the drivers to the clients. The reliability problems can be traced to the city's public works department, over which the City Manager has no control. He has, however, felt a similar lack of control in his dealings with Yellow Cab. He cited a number of specific problems which have been difficult to solve as well as a general lack of enthusiasm on the company's part in attempting to solve image problems. In order to improve the program's image, the City Manager wrote several new provisions into the 1981 contract. These were perceived as stop-gap measures and unnecessary irritations by the owner of Yellow Cab. The City Manager feels that a structural overhaul of the program is necessary if problems are to be solved.

As mentioned earlier, the distribution of program functions requires constant communication between the city and the provider. At the time of the case-study, however, most of the interactions between the two men were occurring through memoranda. Both preferred to keep direct contact to a minimum.

All of this conflict did not portend well for the long-term life of the contract. Yellow Cab was seriously considering not bidding at the next renewal date, and the Manager felt the program should be taken over and operated by a city department.

Portland, Oregon: Lift

Portland's LIFT program was established in 1975 as the major part of a six-part program to serve the transportation needs of elderly, handicapped, and rural residents in a three-county area in and around Portland. Although originally operated by Tri-Met, Portland's public transit authority, Tri-Met's role in the program changed in 1979. Tri-Met now serves as the broker and coordinator of transportation services. Human service agencies who wish to provide transportation for their clients contact Tri-Met, which then contracts with other providers to deliver the actual services.

The procedure to select transportation providers is somewhat complex, because of two factors. First, because a very large geographical area is involved, it has been necessary to contract with four different providers in order to deliver all the service. Four different contracts are necessary because of variations in the geographical areas and types of service provided. Second, under Oregon law a public entity, such as Tri-Met, that wishes to contract with another public entity is not required to use a bid procedure. On the other hand, if the contract is to be made with a private entity, an RFP is required. Thus, in three cases a bid process is followed and one case it is not.

In the three cases where the private sector is involved, potential providers respond to a lengthy RFP by participating in a two-step bid process. The RFPs, written by Tri-Met are about 25 pages in length and are divided into seven (7) major sections. The specifications describe in detail the design of the program including how much money will be spent to provide service and the particulars of business relations and paperwork flow with Tri-Met. Only a few aspects of the program design are left up to the contractor, such as number and type of vehicles.

In the first stage of the bidding process, potential contractors submit their qualifications and Tri-Met determines whether the firm is responsible and able to provide the service. Any firm pre-qualified in the first stage is permitted to submit a bid in the second stage. During the second stage firms simply state how many trips they will provide for the dollar volume Tri-Met intends to spend in the service area. The firm offering the greatest number of trips is awarded the contract.

In practice, the bid process and program administration have been fraught with problems:

1. The Tri-Met Legal department insisted on the two-stage bid process in order to ensure that final selection of the transportation provider is as objective as possible. Tri-Met personnel charged with implementation of the program, however, feel that although this does prevent unqualified firms from bidding, the unit evaluation measure allowed in the final bid award prevents such variables as fleet size, experience, and length of trip from being evaluated.

2. Providers who have been under contract with Tri-Met for a number of years voice a similar complaint by noting that the experience they have gained in running the program seems to have no special value in the bid award process.

3. All of the providers who bid and are currently under contract complain that although the bid process suggests that efficiency is a goal of the program, the fact is that the contractors are paid for actual costs rather than the number of trips. The final payment for service bears little relationship to the original bid for number of trips. In fact, nobody knows how much the trips cost or how efficient the service is.

4. Providers also complain that the bid process acts to alter demand for transportation services. In order to keep costs down but still offer the number of trips required, it is advantageous to provide the shortest, most flexible easily grouped trips, not necessarily the trips the client population needs most. This is especially true where remote areas are being served for the same system average trip cost as in more densely populated areas.

It is interesting to note that the provider most satisfied with the LIFT program is the public provider who negotiated a contract directly with Tri-Met. No RFP was used.

In spite of problems, which are regarded as serious by the contractors, the LIFT program is conducted with a cooperative spirit. Tri-Met has tried to respond to the problems of the contractors. On the other side, the contractors are interested in providing the service and would like to continue. They think the brokerage system is good, and that Tri-Met brings a higher level of knowledge about transportation to the process than would the human service agencies.

Discussion

In reviewing the results achieved and the processes used, it does appear that there is a certain attitude and pattern of activity which is more likely to result in a successful third-party transportation service contract. There are major differences between the processes used in Lawrence and Cleveland, as opposed to those used in Portland and Hartford. Lawrence and Cleveland both began the contracting process with negotiations. Both cities approached their potential contractors with no preconceived notion other than public and private entities could work together to produce manageable programs. The open communication which was initiated by each of the cities as they began the contractual process resulted in a high level of interest, cooperation, and trust from the private sector companies. Throughout the processes, input was solicited from the potential contractors, and their ideas were in fact used in the final design of the programs. After award of the contracts, the open working relationships fostered a flexibility which made it possible to resolve problems as they arose, further ensuring the successful continuation of the contractural arrangements.

There was a difference, of course, in how the two cities finally selected their contractor(s). Lawrence signed contracts with every unit that wished to participate in the program, thus precluding the need for a bid process. Cleveland, on the other hand, chose Yellow Cab as the contractor based on a formal advertised bid.

A second observation regarding the negotiation processes used in Lawrence and Cleveland is that they produced program designs which are relatively simple. Responsibilities of each of the parties are clearly spelled out, none of the parties is overly dependent on another to perform its function, and none of the parties is overly burdened with administrative headaches. These results would logically seem to be a direct result of designing programs based on known resources and working through a process sensitive to the administrative duties being imposed on each other.

In contrast, the approach of both Portland and Hartford, (because it was required by law) was to begin the contractual process with the development of a formal RFP which described in detail how the program was to be operated. This procurement process, which is intended to maximize free and open competition, requires a final bid comprised of a single number so that bids from different companies can be compared objectively.

Throughout the transportation industry, there has been much discussion of the merits of different unit measures. Hartford and Portland both used a "flat rate" measure wherein the agency determines in advance how much money will be spent and the service provider bids on the number of trips he can afford to provide for the price. Unfortunately, while the unit chosen for comparison does afford easy comparison of companies on the chosen measure, it usually only measures quantity of service. Variables such as fleet size, previous experience, and other elements which comprise quality of service are ignored. In Hartford, especially, the critical issue had become quality of service with the city and the contractor at great odds as to what comprised quality service.

While the bid process used in these two cities does truly offer free and open competiton, the City has complete control over the design of the program. It is left to the successful bidder to fit into the program as best he can. As previously noted, the Tri-Met case poses an interesting example in that both competitive advertising and negotiation were used to secure contracts. The County with whom they conducted the negotiation was the only one of the four contractors that was completely satisfied with the contract.

In further contrast to the Lawrence and Cleveland cases, the Portland and Hartford programs are organizationally complex. The "theoretical" programs described in the RFPs have required numerous practical modifications to accommodate the "real" contractors, thus producing many administrative headaches. Portland's problem is largely a result of the enormous geographical area they serve, the fact that they have many contractors, and the complexity of trying to fit numerous unique organizations into one system. In Hartford, much of the complexity is a result of the city's insistence that it retain responsibility for some aspects of the service. The result is that two very independent parties are dependent upon each other to deliver the service. Conflict has thus been built into both program designs.

Recommendations

The success of the programs designed and implemented in the cities of Lawrence and Cleveland can be attributed to the negotiation processes which were used. It makes sense that if the parties to a contract work together to design a program based on the assets that each brings to the agreement, the likelihood that they will arrive at a mutually agreeable and manageable solution is greater. For this reason, we recommend that parties seeking to enter a contractual arrangement for transportation services negotiate to determine the design and management of the program.

Fortunately, with the advent of UMTA Circular 4220.1A, Guidelines for Third-Party Contracting, it is now possible for many organizations who receive UMTA funds and who have third party contracts to negotiate service contracts. UMTA now sanctions competitive negotiation when conditions are not appropriate for the use of formal advertising. As previously discussed, a single unit measurement is not, in most cases, an appropriate evaluation measure of complex transportation service contracts.

Competitive negotiations for transportation service contracts should be conducted as for any other competitively negotiated contract. Anyone interested in using the procedure should consult Circular 4220.1A and appropriate UMTA or State personnel with questions.

Very generally, the competitive negotiation process is as follows: Proposals should be solicited from several qualified sources using an RFP. The RFP, however, need not spell out the detailed design of the program as was done in Hartford and Portland. It should cite what is generally required, with specific details included where necessary (such as levels of insurance required). The RFP should identify all significant evaluation factors, including price or cost where required and their relative importance. Procedures for technical evaluation should be developed and then the bids which were received should be evaluated accordingly. After the evaluation procedure has identified the vendors offering the best proposals, the public entity may engage in negotiations with those vendors to arrive at the best and final offers. An award may then follow to the responsible offerer whose proposal will be the most advantageous to the public entity, price and other factors considered.

While this system does not offer quite the openness and flexibility of the system used in Lawrence, it is a major improvement over the formal advertising process which has often been required to enter a service contract. Within the allowable negotiation process, it should be much easier to arrive at a mutually agreeable program design and contract than has been possible previously.

Mary Hough, Director of Marketing and Planning, Tri-County Transit, Orlando, Florida 32805.

Ann Zeltmann, Director of Mass Transportation, New Mexico Transportation Department, Santa Fe, New Mexico 37210.

ACCIDENTS OF ELDERLY PEDESTRIANS IN ISRAEL: THEIR RELATION TO BEHAVIOUR AND HOUSING LOCATION

Allan Katz, Alit Elgrishi and Lily Guttmann

Background and Purpose

Although well publicized statistics for Israel and other countries have made it clear that the elderly are a particularly over represented group in the total number of injured pedestrians, no major safety expenditures have ever been made on their behalf in Israel. This posture may in part be attributed to diminishment of the issue as a high priority area as is the case with other problems of the aged in developing countries. In addition, this failure to budget serious sums is due to the lack of a rational framework for countermeasures for dealing with traffic accidents of an elderly pedestrian.

The overall aim of the research and development project, whose first stages are described in this article, is to improve the safety of walking trips made by elderly persons in urban areas. The rationale supporting this project may be summarized as follows:

Priorities	*Alternatives*
1. problems of the elderly in developing countries	problems of other age groups in developing countries
2. transport problems of the elderly	other problems of the elderly: health, housing
3. walking trip problems of the elderly	other modal trip problems: bus, taxi, train
4. safety in walking	other problems in walking
5. walking in the vicinity of home	walking elsewhere

The policy decisions with respect to resource allocation for priorities 1 and 2 need to be compatible with the decision making constraints applied to other needs of developing countries—needs which are extremely urgent, basic, and elementary. Priority 3, the walking trip, is regarded as a high priority transportation problem by virtue of its predominance as a mode of travel for the mobile elderly population. The prevention of bodily harm through the improvement of pedestrain safety is considered a national goal equal in importance to any other. Finally, walking trips in the vicinity of home are emphasized in light of family oriented activity pattern common to the elderly in developing countries.

The immediate aims of the first stage of the research were:

a. to determne the accident involvement of elderly pedestrians on roads in different areas of the city—residential, industrial, commercial.

b. to ascertain the elderly pedestrian's level of understanding of the traffic environment—and his "declared" behavior in respect to the problems which this environment presents

Description of Study Methodology

The study consisted of two main parts:

a. Mapping the location of elderly pedestrian injury accidents;

b. Interviewing a sample of mobile (not housebound) elderly pedestrians.

In addition, national statistics covering 3 years of elderly pedestrian accidents were analyzed in order to provide an overall picture of the problem, and 200 police accident files involving elderly pedestrians were analyzed as well.

Mapping Accidents of Elderly Pedestrians

1. *City Sample*

Nine Israel cities were selected for study on the basis of size (range 19,000 to 230,000 persons), and classified either as "new," "historic," "urban" or "rural" in character and infrastructure.

2. *City-area Classification*

a. On a map of each of the nine cities selected for study,the following areas were marked and color coded:

0—undeveloped land areas—this category included only major tracts of land, and did not include small parks, open parcels on city streets, university campuses, etc.

1—central business district

2—main arterial roads

3—industrial zones

4—residential neighbourhoods

b. A print-out of all accidents which occurred in the city for the past 3 years was obtained from the computerized accident files, giving the street and house number of each accident.

c. The location of each accident on the map was determined, and its area type, 1 through 4, recorded on the computer listing.

d. A new accident file was created for each city, containing the standard detail (on vehicle, road, environment and injured persons) of the accidents as given by the Police and the Central Bureau of Statistics as well as the new code (1-4) for the type of urban area or road in which the accident occurrred. The key "standard detail" of interest for this study was the age of injured pedestrian.

3. *Area Boundaries*

The determination of the boundaries of the industrial zones and undeveloped land tracts was made on the basis of the official city maps. The boundary of the Central Business District (CBD) and the determination of main arterials was on the basis of visits to each city with reference to commercial activity and vehicle and pedestrian flow and activity. Arterials were defined to include that part of the road lying outside the boundary of the CBD through the end limits of the road's function as an arterial—often at the border of the city where it becomes transformed into an interurban route. The area remaining after delineation of the above areas was entirely made up of the city's various residential neighborhoods. The streets in these residential neighborhoods included local streets, neighborhood collector streets, and streets in neighborhood shopping areas. Not included were arterial roads passing through residential neighborhoods.

Interview of Elderly Pedestrains

Study Sample

The criteria used in selecting the 500 elderly persons to be interviewed were influenced by the following:

a. 70 percent of the pedestrian accidents involving persons over the age of 65 occur in the 3 large cities of Tel Aviv, Jerusalem and Haifa;

b. pedestrian accidents occur primarily to active, nonhomebound persons with reasonable health;

c. accidents occur to persons of both sexes from the age 65 through 80+;

d. drivers represent a group of pedestrians who most likely differ from pedestrians who do not drive.

Accordingly, a sample of 487 persons was chosen, all in the city of Haifa, all of whom were engaged in an activity away from their home at the time of interview. The final sample had the following characteristics:

Age Group	*Number*	*Percent in Sample*	*Percent in National Population 65+*
65-69	144	30	36
70-74	180	37	31
75-79	82	17	18
80+	81	16	15
Totals	**487**	**100**	**100**

It was found that:

- 487 persons represent a 1.6 percent sample of the Haifa population over the age of 65;
- Driving licenses were held by 24 percent of the sample;
- Hebrew language knowledge — 72 percent good; 28 percent poor to fair;
- Males—56 percent; Females 44 percent.

Interview Schedule

Each elderly person was personally interviewed by a trained person using a closed end interview schedule covering the following topics:

a. health of the respondent

b. knowledge of the Hebrew language

c. travel patterns: number of trips, distance to amenities, mode, etc.

d. driving experience, if licensed to drive

e. knowledge of traffic signs

f. knowledge of safe walking habits

g. knowledge of and attitude towards selected traffic safety topics.

Knowledge of signs and walking habits of respondents were examined through presentation of 16 pictures, accompanied by a series of questions, with some opportunity for open-end responses.

Analysis of Accident Statistics and Policy Files

Statistics for 3 years of accidents involving elderly pedestrians were analyzed in detail with respect to place, severity and personal characteristics of the injured pedestrian. To ascertain trends, if any, some data were analyzed over a 10 year period. A second set of data analyzed was a group of 200 police files, representing all accidents to elderly pedestrians in the Haifa area over a 3 year period.

TABLE 1

Percent of Pedestrians Injured by Age, Area and Road Type All Cities Studies

	Age				
	0-14	*15-24*	*25-64*	*65+*	*Total*
Central Business District	11	27	40	33	28
Arterial Road	35	38	34	38	36
Industrial Zone	0	2	2	0	1
Residential Area	54	33	24	29	35
Total	100	100	100	100	100
Percent of accidents	29	13	34	24	100

Locational Aspects of Pedestrain Accidents Involving Persons Over 65

Areas of the City in Which Accidents Occur

For all towns in the sample, 29 percent of elderly pedestrian injuries occurred on residential roads. The balance of injuries took place on arterial roads (38 percent), and in the central business districts (33 percent). Table 1 shows that data for the elderly compared to other age groups.

The Residential Location of the Elderly and Its Relation to Traffic Safety

In the above macro analysis of the location of pedestrian accidents by type of road and type of city area, no account was taken of where the elderly persons actually reside. This question was investigated only for the city of Haifa.

Haifa is divided into 64 Geographical Statistical Areas, for each of which the age distribution of the population is known. Traffic data were collected for the roads in each statistical district, and a rating of average traffic environment was assigned to the district. The volumes of daily traffic corresponding to the three levels of traffic environment were:

1. simple environment—0 to 2999 vehicles per day
2. problematic—3000 to 7000 vehicles per day
3. difficult—over 7000 vehicles per day

The results of the analysis of residential location in Table 2 by population age and "traffic environment" indicate that by virtue of their housing location, a statistically significant proportion of elderly people are exposed to a difficult and unsafe traffic environment than any other age group.

The Traffic Environment of Old Age Institutions

The location of 20 institutions providing services to the elderly in Haifa were analyzed with respect to their "traffic environment." It was found that 60 percent of the old age clubs and old age homes were located in areas with a problematic traffic environment, while 30 percent of these institutions were located in areas with a difficult and unsafe traffic environment.

The Distance from Residence to Accident Site

From the police files covering 200 pedestrian accidents in Haifa, it was found that 55 percent of the accidents took place within walking distance of the elderly person's home.

When the distance from home to accident site was analyzed by type of street at the site, it was found that two thirds of the accidents on arterial roads and one quarter of those in the CBD were within walking distance of home.

Traffic Knowledge and Behavior of Elderly Persons

Knowledge of Traffic Signs

Pictures of 8 common traffic signs were presented for identification to the interviewees. The signs were: stop, yield right of way, no entry, bus stop, traffic signal, crosswalk, flashing yellow warning, pedestrian barrier. Of the replies given, 46 percent were correct and 54 percent incorrect. Over half the replies regarding the specific pedestrian signs (crosswalk, bus stop, pedestrian barrier) were correct.

In addition, it was found that:

- 77 percent of drivers and 31 percent of non-drivers answered correctly.
- 50 percent of those with some knowledge of Hebrew answered correctly; 35 percent of those with poor knowledge of Hebrew answered correctly.
- 56 percent of those age 65-69 answered correctly; 36 percent of those over 80 answered correctly.
- 56 percent of the men's replies were correct; 35 percent of the women's were correct.

These four attributes accounted for 48 percent of the variance among respondents with regard to knowledge

TABLE 2

The Distribution of the Population of Haifa by Age Group and Traffic Environment of Age Group's Housing Location (1977)

	65+		*15-64*		*0-14*		*Total*	
Location	*Percent*	*No.*	*Percent*	*No.*	*Percent*	*No.*	*Percent*	*No.*
Simple	3.0	906	3.0	5654	4.6	2588	3.9	9148
Problematic	63.7	19023	73.6	107352	74.2	41797	72.5	168172
Difficult	33.3	9921	22.4	32889	21.2	11991	23.6	54801
Total	**100**	**29850**	**100**	**145895**	**100**	**56376**	**100**	**232121**

of signs. Possession of a driver's license accounted for 41 percent of the variance.

Knowledge of Safe Walking and Road Crossing

Pictures of 8 walking problems were presented for comment. The main situations illustrated were: use of tunnel, no sidewalks, crossing close to but not on a crosswalk, safety barrier at curb edge. In terms of walking safety, 66 percent of the replies given were correct and 34 percent incorrect.

- 79 percent of drivers answered correctly; 64 percent of nondrivers answered correctly.
- 74 percent of respondents aged 65-69 answered correctly; 55 percent of those age 80 and above answered correctly.
- 80 percent of those with good Hebrew language were correct; 59 percent of those with poor Hebrew answered correctly.
- 72 percent of men answered correctly; 58 percent of women answered correctly.

These four attributes explained 43 percent of the variance among respondents with regard to knowledge of safe walking; possession of a driver license explained 29 percent of the variance.

Walking Patterns

1. Amount of Walking

- 58 percent walked every day (51 percent—75 to 79 year olds; 49 percent—80 year olds);
- 23 percent walked about three times per week;
- 8 percent walked about once per week;
- 11 percent no reply.

As may be expected, healthy persons of all ages walked more than unhealthy persons. And since health tends to decline with age, especially for women, women walked less than men.

2. Walking Trip Purpose and Length

- Over 90 percent of the walking trips to the bank, medical clinic, shopping, and old age club took less than 15 minutes.
- Walking trips to friends and relatives averaged half an hour.

Actions of Pedestrians and Drivers Involved in Accidents

The following problems were identified from an analysis of 200 police files covering pedestrian accidents for those age 65 and over resident in the Haifa area:

- Crossing between parked vehicles: occurred in the midblock, or as a result of illegally parked cars near crosswalks and bus stops.
- Bus stops: a high percentage of pedestrians were alighting from or on their way to buses on main road.
- Standing and awaiting vehicles: crossing between vehicles in queue waiting for a signal or stopped for other reasons.
- Intersections: turning vehicles not anticipated by pedestrians, or pedestrian was not seen by driver.
- Vehicle manoeuvers at curb: frequently pedestrians were hit when vehicle was turning, or car door was opened in a way that injured the pedestrian.
- Sidewalks: vehicle mounted sidewalk part of the driveway to offload or was parked illegally.
- Responsibility: the research team which reviewed the 200 files judged the driver responsible for the accident in 57 percent of the cases, the pedestrian in 23 percent of the cases, in 20 percent the team was undecided.

Discussion

Among the first Israel statistics analyzed for this research were trends in age specific pedestrian injury rates for the 10 year period 1971-80. This analysis showed that the rates for all age groups declined monotonically by 33 percent during the period. Such a general decline raises the question as to how the absence, during the 10 year periods of countermeasure programs for the elderly can be reconciled with the improvement in their injury rates, and why the numerous programs for children operating during the same period did not result in a proportionately larger reduction in their injury rate. This confusion regarding the effectiveness of countermeasures must be considered within the context of other factors making it difficult to develop a rational accident reduction framework for elderly pedestrians:

a. The failure of research to identify any clear behavioral differences on the part of the elderly in traffic. Wilson and Grayson (1980) conclude that the elderly "do not appear to form a distinct sub-group within the pedestrian population."

b. The established finding that old people are less exposed to traffic — as measured by kilometers walked and roads crossed (Todd and Walker, 1980; Doar and Goodwin, 1976).

c. The accepted premise that older people are experienced, conservative and careful. With respect to car safety measures, for example, older people tend to use seat belts. However, old people cease to drive when their health weakens or other physical disturbances begin their appearance (Ysander and Herner, 1976).

The general picture which emerges is that we are dealing with the population group least likely to be involved in accidents—yet, the statistics tend to prove otherwise.

The resarch described in this report has two main findings—one relevant to the general problem of understanding the accidents of the elderly, and the second to the issue of what constitutes a practical pedestrian program for developing countires.

We find that:

1. The exposure of the elderly population to threatening traffic conditions by virtue of housing location is one element in understanding the accidents of elderly pedestrians. Studies in urban geography (Gonen and Sonis) and life cycle research in housing (Doling, 1976) have made sufficiently clear the correlation of aging population to aging housing, and have almost always located this housing within or at the fringes of the city center, or in and near other commercialized areas and along streets which became main arteries in the course of city development. This research has, in turn, correlated the housing location of elderly pedestrians to areas and streets having severely threatening and above average unsafe traffic characteristics. Furthermore, the high frequency of short trips on foot to services located on highly trafficked streets, as reported by the elderly persons interviewed, may mean that their "real" exposure to accident risk is much higher than would be indicated by the number of kilometers they walk per day. Dahlstedt (1979/80) has also noted the apparently high traffic exposure of the elderly due to daily walking trips, commenting that "these old-aged people constitute a very active part of the whole pedestrian population."

2. The elderly pedestrian's limited knowledge of traffic signs and safe walking habits have implications for accident countermeasure programming in developing countries. Two characteristics were found to differentiate those elderly persons with reasonable knowledge from those with unsatisfactory knowledge: (a) car driving experience, and (b) good knowledge of the Hebrew language. Many developing countries have communication problems resulting from a tradition of multiple ethnic languages, or there is significant illiteracy among their adult and elderly populations. These situations are unlikely to change quickly. Likewise, despite the rapid trend of increased motorization in developing countries, the level of driver licensure among those who are today 40 years old or more, is unlikely to change. That is to say that there is likely to be a very large group of elderly non drivers for some generations to come. Improving the traffic knowledge of these two specific groups of elderly persons, while overcoming the general problem of program delivery and communication with a dispersed elderly population, would appear to be an extremely costly effort with little hope of success.

Conclusion

There is obviously a need with respect to the accidents of elderly persons for more basic research and more innovative counter-programming of experimentation and evaluation. Currently, however, there would appear to be little choice for developing countries, as well as developed countries, but to adopt the approach of helping the older pedestrian by making his "tasks less demanding" (Waller, 1974). There are many well developed methods for accomplishing such task simplification for the older pedestrian. Such methods range from low cost measures such as speed control bumps and sidewalk maintenance, to more expensive solutions such as well designed pedestrian bridges and pedestrianised streets of varying types, all of which cost money. Application of this approach can be oriented partially to those areas of the city where the elderly tend to live and are injured and to the specific sites where they congregate and carry out their daily activities (Millas, 1980).

References

Dahlstedt, S. "Slow Pedestrians, the Voice of the Pedestrian." Winter 1979 / 80, pp. 31-37. (Also Conf. on Transport for the Elderly, Proc., 1978.)

Daor, E. and Goodwin, P.B. "Variations in the Importance of Walking as a Mode of Transport." Research Memorandum 487, GLC, U.K., 1976.

Doling, J "The Family Life Cycle and Housing Choice." Urban Studies (1976), 13, 55-58.

Gonen, A. and Sonis, M. "The Geography of Age-Structure in Metropolitan Tel Aviv." Report D-37-79, 30 pgs., Brookdale Institute, Jerusalem.

Millas, A.J. "Planning for the Elderly Within the Context of a Neighbourhood" Ekistics, Vol. 47, 283 July, 1980, pp. 264-273.

Todd, J.E. and Walker, A. "People as Pedestrians." HMSO, U.K., 1980.

Waller, J.A. "Injury in Aged." N.Y. State J of Medicine, Nov. 1974, 2200-2208.

Wilson, D.G. and Grayson, G.B. "Age Related Differences in the Road Crossing Behaviour of Adult Pedestrians" TRRL Lab. Report 933, 12 pgs. Transport Road Research Laboratory, U.K., 1980.

Ysander, L. and Herner, B. "The Traffic Behaviour of Elderly Male Automobile Drivers in Gothenburg, Sweden." Accident Analysis and Prevention, Vol. 8, pp. 81-86, 1976.

Allan Katz, Deputy Director; Alit Elgrishi and Lily Gutmann, Transportation Research Institute, Technion, Israel Institute of Technology, Haifa, Israel.

VEHICLE DISPATCHING SYSTEM FOR SPECIALIZED TRANSPORTATION

Shinya Kikuchi

Introduction

The effectiveness and efficiency of a demand responsive transportation system for elderly and handicapped persons depends heavily on the vehicle dispatching scheme. Operating efficiency, operating cost, vehicle and driver requirements, and passenger satisfaction are affected by the manner in which vehicles are dispatched to meet passenger demand. Because of the dispersed passenger trip origins and destinations and desired departure times, the vehicle movements of demand responsive system contain a significant share of empty vehicle miles and idle time in the daily operating cycle; for example, Delaware's demand responsive transportation, Delaware Administration for Specialized Transportation (DAST) operating statistics in fiscal year 1983 shows that 35 percent of total annual vehicle miles are empty miles, and 50 percent of annual driver hours are empty travel or idle time. Scheduling of vehicles to increase passenger loading and to reduce empty vehicle travel and idle time, therefore, is an imperative element of vehicle dispatching. This paper discusses the problems associated with vehicle dispatching, and then proposes a vehicle dispatching method to minimize empty vehicle travel.

Vehicle Dispatching Practices and Problems

A typical demand responsive transportation system handles two types of passengers: regular pre-registered passengers who repeat trips on certain days (e.g., visits to doctor's office for treatment), and occasional passengers. The regular passengers' trip information is usually known to the dispatchers. The occasional users are required to make trip reservations well in advance, typically 24 hours prior to their trips. Each request contains name, origin/destination addresses, sponsoring agency (billing agency), type of disability, and trip start/return times. The dispatcher compiles all the trip requests (regular and occasional) and develops vehicle routings for the next day. In developing the vehicle routings, at least the following aspects are considered:

- Operating efficiency: minimum empty vehicle travel miles and time, and minimum number of vehicles and drivers through multiloading of passengers and optimum vehicle routing;
- Passenger satisfaction: maximum satisfaction of passenger trips with minimum passenger inconvenience and comfort, including minimal time adjustment and circuitous path;
- Equitable route assignment to drivers: fair and equitable allocation of the number of trips, the number of passengers, miles, hours and area coverage among the drivers.

The operating efficiency is usually improved by aggregating passengers with close proximities of origin/destination addresses and desired departure/arrival times. Passenger satisfaction, by contrast, is generally inversely proportional to the passenger aggregation; the more passengers are aggregated to a vehicle trip, the more inconvenience is experienced by the passengers because of extra travel time and circuitous paths. Passenger comfort is also inversely related to passenger aggregation. The degree of passenger aggregation is determined by the dispatching decision variables including zone size, maximum deviation between scheduled and desired trip start times, maximum travel time on the vehicle, maximum nember of passengers on the vehicle at one time, etc. The limiting value for each varible depends upon the operation and demand characteristics of the demand responsive transportation system, such as geographic setup of the area, trip purpose, passenger disability type, etc. The equitable route assignment among the drivers is another important consideration by the dispatcher. Drivers' area knowledge and driver/passenger familiarity are additional considerations, particularly for preregistered elderly and handicapped clients.

In addition to these conflicting requriements, factors which mitigate the efficiency of operation are variations of travel time due to traffic congestion, vehicle standing time for passenger pick-up/drop-off, no show, and vehicle breakdown. These requirements and uncertainties make vehicle dispatching an extremely complex task.

Traditionaly, this task has been handled manually by a dispatcher who is familiar with passenger needs, driver desire, traffic conditions and other local demand and operational condition. In recent years, efforts have been made to prepare a more structured schedule with one or more objectives (for example, minimum number of vehicles) using mathematical algorithms. In the following sections, a vehicle schedule preparation process which minimizes empty vehicle travel time and distance is proposed. Since this process minimizes only the total empty vehicle travel time and distance, it does not pose the problems of trade-offs between operating efficiency and passenger level-of-service due to passenger aggregation on loaded trips.

Vehicle Dispatching Model: Objective and Output

The objective of the model is to assign vehicles between passenger drop-off point/time and passenger pick-up point/time so as to minimize empty vehicle travel time and idle time. The outputs from the dispatching algorithm include:

- Routing instructions for each vehicle: a travel sequence with respect to locations and time (garage to garage),
- Fleet size required to meet the passenger trip requests,
- Identification of passenger trip requests which cannot be satisfied with the given fleet size,
- Estimated vehicle miles and hours (loaded and empty trips, respectively).

Optimization Algorithm

To facilitate the explanation in the following sections, a demand responsive transit system consisting of four zones and one garage (which is located in one of the zones) will be used as an example. Figure 1 shows the example service area and the zone designations. Tables 1 and 2 are the matrices of relative travel time in time periods and travel distance for all zone pairs. In Table 1, "zero" entries indicate that the corresponding trips are accomplished within the time period.

The schedule development process consists of the following steps:

Step 1. Compilation of passenger trip requests,
Step 2. Development of optimum empty vehicle movements,
Step 3. Development of vehicle routing instructions.

Step 1. Compilation of Trip Requests,

Each passenger trip request contains at least the following attributes: origin and destination addresses and desired departure time. The trip origin and destination addresses are translated into their respective zone numbers; thus, each passenger trip is registered as a zone-to-zone trip. This process is carried out manually by the dispatcher when the trip request is registered, or automatically by a computerized address coding system. Similarly, the desired departure time is translated into the corresponding time period. Using the zone-to-zone travel time matrix, the arrival time period at the destination zone is also determined.

Each trip request now bears the folowing four attributes: origin zone number (= i), destination zone number (= j), departure time period (= m), and arrival time period (= n).

All the passenger trip requests are summarized in a matrix in which each element shows the number of trip requests which have the same trip attributes: origin zone and departure time period, and the destination zone and arrival time period. This matrix is called a passenger trip request matrix and is shown in Table 3.

The passenger trips are then translated into the corresponding vehicle trips by dividing the elements in Table 3 by the vehicle capacity as shown in Table 4.

Step 2: Development of Optimum Empty Vehicle Movements

(1) Problem formulation. In Table 4, the row at the bottom represents the total number of vehicle arrivals at each zone and time period. Since a loaded vehicle arrival means that the vehicle becomes available for an empty trip, the bottom total row of Table 4 represents an empty vehicle supply at respective zone and time period. By incorporating the empty vehicle supply at the garage before the day's operation (at time period "zero"), the empty vehicle supply vector is presented at the bottom row of Table 4, assuming fleet size of 40. Similarly, the column on the right shows the total number of loaded vehicle departures from each zone and time period representing the empty vehicle demand. Since all vehicles must return to the garage at the end of the day, the empty vehicle demand vector should also include the vehicle demand at the garage at the last time period as shown in the far right column of Table 4.

The problem is how to assign vehicles from the empty vehicle supply zones to empty vehicle demand zones considering time periods of vehicle availability and demand. This is a linear programming transportation or assignment problem with minor complications due to the travel cost functions.

(2) Development of travel cost matrix. In order to solve the linear programming problem, the cost of empty vehicle trips for each zone/time period pair must be known. The unit vehicle cost for each assignment is denoted as: T(i,j,m,n) = travel cost from zone i (departing in time period m) to zone j (arriving in time period n) per vehicle.

In developing values of T(i,j,m,n), the feasibility of vehicle trips between i and j must be examined first, considering the sequential relationship between time periods m and n. A vehicle is not able to arrive at destination zone j at time period n by departing the origin zone i at time period m, if (1) arrival time period n is before the departure time period: n ◄ m, or (2) even n ► m, if the travel time between i and j is greater than the time difference between time period m and n. Under these circumstances, T (i,j,m,n) assumes a large value to prevent the vehicle assignment in the subsequent LP solution.

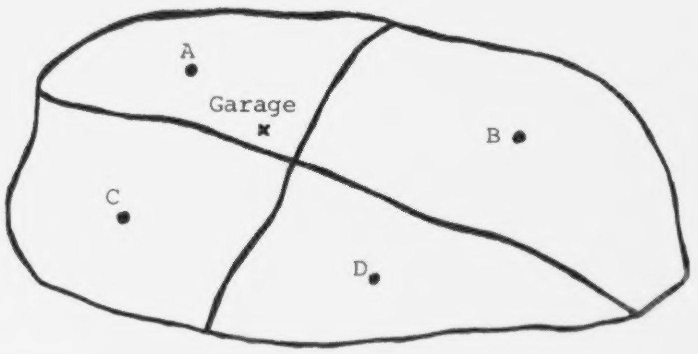


Fig. 1 EXAMPLE SERVICE AREA AND ZONE DESIGNATIONS

TABLE 1 ZONE-TO-ZONE TRAVEL TIME MATRIX
(IN TIME PERIODS)

		DESTINATION ZONES			
		A	B	C	D
ORIGIN ZONES	A	0	2	1	1
	B	2	0	1	2
	C	1	1	0	1
	D	1	2	1	1

TABLE 2 ZONE-TO-ZONE TRAVEL DISTANCE MATRIX

		DESTINATION ZONES			
		A	B	C	D
ORIGIN ZONES	A	0	1.0	1.5	1.2
	B	1.0	0	2.0	0.5
	C	1.5	2.0	0	1.0
	D	1.2	0.5	1.0	0

TABLE 3 PASSENGER TRIP REQUEST MATRIX

		DESTINATION ZONES AND TIME PERIODS												
		A			B			C			D			
	TIME PERIODS	1	2	3	1	2	3	1	2	3	1	2	3	TOTAL
ORIGIN ZONES AND TIME PERIODS A	1						8		9			3		20
	2						5			4			1	10
	3													0
B	1			10					5				6	21
	2													0
	3													0
C	1		1											1
	2						6						4	10
	3													0
D	1					7								7
	2			7									5	12
	3													0
TOTAL		0	1	17	0	7	19	0	14	4	0	3	16	

TABLE 4 LOADED VEHICLE TRIP MATRIX

		DESTINATION ZONES AND TIME PERIODS												
		A			B			C			D			
	TIME PERIODS	1	2	3	1	2	3	1	2	3	1	2	3	TOTAL
ORIGIN ZONES AND TIME PERIODS A	1						1		1			1		3
	2									1			1	2
	3													0
B	1			1					1				1	3
	2													0
	3													0
C	1		1											1
	2						1						1	2
	3													0
D	1						1							1
	2			1									1	2
	3													0
TOTAL		0	1	2	0	0	3	0	2	1	0	1	4	

TABLE 5 ZONE-TO-ZONE UNIT TRAVEL COSTS

ORIGIN ZONES AND TIME PERIOD		DESTINATION ZONES AND TIME PERIODS: G	A			B			C			D		
	TIME PERIODS	4	1	2	3	1	2	3	1	2	3	1	2	3
G	0	28	7	14	21	15	15	22	8.5	15.5	22.5	8.2	15.2	22.2
A	1	21	0	7	14	M	M	15	M	8.5	15.5	M	8.2	15.5
	2	14	M	0	7	M	M	M	M	M	8.5	M	M	8.2
	3	7	M	M	0	M	M	M	M	M	M	M	M	M
B	1	22	M	M	15	0	7	14	M	9	16	M	M	14.5
	2	15	M	M	M	M	0	7	M	M	9	M	M	M
	3	8	M	M	M	M	M	0	M	M	M	M	M	M
C	1	22.5	M	8.5	15.5	M	9	16	0	M	14	M	8	15
	2	15.5	M	M	8.5	M	M	9	M	0	7	M	M	8
	3	8.5	M	M	M	M	M	M	M	M	0	M	M	M
D	1	22.2	M	8.2	15.2	M	M	14.5	M	8	15	0	7	14
	2	15.2	M	M	8.2	M	M	7.5	M	M	8	M	0	7
	3	8.2	M	M	M	M	M	M	M	M	M	M	M	0

M = Very Large Number indicating impossible assignment, G = Garage

TABLE 6 EMPTY VEHICLE TRIP MATRIX

ORIGIN ZONES AND TIME PERIODS		DESTINATION ZONES AND TIME PERIODS: G	A			B			C			D			
	TIME PERIOD	4	1	2	3	1	2	3	1	2	3	1	2	3	TOTAL
G	0	30	3	1		3			1			1	1		40
A	1														0
	2			1											1
	3	2													2
B	1														0
	2														0
	3	3													3
C	1														0
	2									2					2
	3	1													1
D	1														0
	2												1		1
	3	4													4
TOTAL		40	3	2	0	3	0	0	1	2	0	1	2	0	

Otherwise, the values of T (i,j,m,n) may be calculated based on the travel distance only, or on a combination of travel distance and time difference between m and n, such as; $T(i,j,m,n) = a.d_{i,j} + b(n-m).e$ (a = cost per unit distance, $d_{i,j}$ = distance between i and j, b = cost per unit time, e = duration of a time period)

Table 5 is a travel cost matrix prepared assuming $a = 1$, $b = 0.7$ and $e = 10$ in the above expression.

(3) Optimization. Since the objective is to minimize the total cost, the sum of the product of cost (a function of distance and/or time) and vehicle volume, the model is now summarized as:

$$\text{Miminize } \{\sum_i \sum_j \sum_m \sum_n [T(i,j,m,n) \,.\, X(i,j,m,n)]\}$$

where $X(i,j,m,n)$ = the number of empty vehicles assigned to the trip from zone i/time period m to zone j/time period n, subject to:

$$\sum_j \sum_n X(i,j,m,n) = S_{i,m}, \text{ and } \sum_i \sum_m X(i,j,m,n) = D_{j,n},$$

where $S_{i,m}$ = empty vehicle supply (availability) at zone i/time period m, $D_{j,n}$ = empty vehicle demand at zone j/time period n. Since the total empty vehicle supply ($\Sigma S_{i,m}$) and the total empty demand ($\Sigma D_{j,n}$) are equal, the above formulation is a balanced LP transportation problem.

For example, using the values of Tables 4 and 5 for $S_{i,m}$, $D_{j,n}$ and $T(i,j,m,n)$, respectively, the problem was solved by a transportation problem package written for APL (A Programming Language), and the derived optimum empty vehicle trip matrix is presented in Table 6. For an actual problem, the sizes of the matrices can be very large due to the combination of zones and time periods. APL, when compared with FORTRAN or BASIC, is particularly efficient for a large size LP problem and matrix operations like this problem.

This LP transportation problem can also be formulated as a network flow problem in which nodes represent loaded vehicle trips and links represent empty vehicle trips connecting loaded vehicle trips (nodes). A link exists only when the empty vehicle trip is feasible between two loaded vehicle trips. The two end points of the network are the garage at the beginning of the day and the garage at the end of the day. The minimum sets of paths which traverse the network passing all the nodes represents the minimum number of vehicles to satisfy the day's travel requests.

(4) Examination of the results. The results of the LP problem must be examined to determine if the solution is indeed feasible. If there is a vehicle assignment to an element for which the travel cost, T (i,j,m,n), is the very large number in the travel cost table, the empty vehicle has been assigned to a trip which is impossible to achieve.

Attention should also be directed to the vehicle assignment from the garage at time period 0 to the garage at the last time period. This value indicates the number of vehicles not used (the number of vehicles staying at the garage throughout the time periods). In our example, the number of unused vehicles is 30; in other words, 10 (40-30) vehicles are sufficient to handle all the passenger trip requests in Table 3. Since the empty vehicle travel and idle time is minimized, the fleet size shown represents the minimum to handle the passenger trips.

Step 3: Development of Vehicle Routing Instructions

After the empty vehicle movements were optimized, the next task is to prepare a complete vehicle routing sequence by tracing the empty vehicle movements and the loaded vehicle movements, alternately. Suppose in the empty vehicle trip matrix, S empty vehicles are sent from the garage to zone j/time period n, the next step is to look at the loaded vehicle trip table for movements originating from zone j/time period n. After the destination of the loaded vehicle trip from j/n are identified, then the empty vehicle trip table must again be ascertained to follow the movements, and so on. The original 40 empty vehicles may branch out to take different trip paths; therefore, the vehicle trip sequence is developed by following the empty and loaded vehicle tables alternately, starting at the movements from the garage and ending to the garage on the empty vehicle trip table. In the example, by following Tables 6 and 4 alternately, the vehicle routing instruction for the 10 vehicles were prepared as shown in Figure 2.

The vehicle trip paths identified by zone number and time periods are later replaced by the addresses and the desired departure time originally requested by the passengers, to prepare the individual vehicle routing instructions.

The Procedure for Vehicle Routing Development

The procedure of the proposed vehicle dispatching scheme is summarized as the sequence of the following activities:

Activity 1: The passenger trip requests received by the telephone operator are compiled (preferably a day ahead).

Activity 2: The origin and destination addresses of the trip requests are identified by zone numbers. (This activity may be conducted at Activity 1 simultaneous to the receipt of trip requests, when the computer address coding system is interactive).

Activity 3: The departure time, and the arrival time estimated by the zone-to-zone travel time table are converted to the respective time periods. Each trip request

VEHICLE										
1	LOCATION:	Garage	$\xrightarrow{(E)}$	A	$\xrightarrow{(L)}$	B	$\xrightarrow{(E)}$	Garage		
	TIME PERIOD:	0		1		3		4		
2	LOCATION:	Garage	$\xrightarrow{(E)}$	A	$\xrightarrow{(L)}$	C	$\xrightarrow{(L)}$	B	$\xrightarrow{(E)}$	Garage
	TIME PERIOD:	0		1		2		3		4
3	LOCATION:	Garage	$\xrightarrow{(E)}$	A	$\xrightarrow{(L)}$	D	$\xrightarrow{(L)}$	A	$\xrightarrow{(E)}$	Garage
	TIME PERIOD:	0		1		2		3		4
4	LOCATION:	Garage	$\xrightarrow{(E)}$	A	$\xrightarrow{(L)}$	C	$\xrightarrow{(E)}$	Garage		
	TIME PERIOD:	0		2		3		4		
5	LOCATION:	Garage	$\xrightarrow{(E)}$	B	$\xrightarrow{(L)}$	C	$\xrightarrow{(L)}$	D	$\xrightarrow{(E)}$	Garage
	TIME PERIOD:	0		1		2		3		4
6	LOCATION:	Garage	$\xrightarrow{(E)}$	B	$\xrightarrow{(L)}$	A	$\xrightarrow{(E)}$	Garage		
	TIME PERIOD:	0		1		3		4		
7	LOCATION:	Garage	$\xrightarrow{(E)}$	B	$\xrightarrow{(L)}$	D	$\xrightarrow{(E)}$	Garage		
	TIME PERIOD:	0		1		3		4		
8	LOCATION:	Garage	$\xrightarrow{(E)}$	C	$\xrightarrow{(L)}$	A	$\xrightarrow{(L)}$	D	$\xrightarrow{(E)}$	Garage
	TIME PERIOD:	0		1		2		3		4
9	LOCATION:	Garage	$\xrightarrow{(E)}$	D	$\xrightarrow{(L)}$	D	$\xrightarrow{(E)}$	Garage		
	TIME PERIOD:	0		2		3		4		
10	LOCATION:	Garage	$\xrightarrow{(E)}$	D	$\xrightarrow{(L)}$	B	$\xrightarrow{(E)}$	Garage		
	TIME PERIOD:	0		1		3		4		

L: Loaded Movement

E: Empty Movement

FIG. 2 VEHICLE ROUTINGS

now carries four attributes: origin and destination zones, departure and arrival time periods.

Activity 4: A pasenger trip table is prepared and a loaded vehicle trip matrix is developed.

Activity 5: The vectors of empty vehicle supply and empty vehicle demand are developed from the bottom row and the right total column of the loaded vehicle trip table, respectively. The number of vehicles in the garage at the beginning and the end of the day are added to the vehicle supply and the vehicle demand vectors.

Activity 6: Travel cost matrix for the LP problem are developed using the zone-to-zone travel distance and zone-to-zone travel time matrices.

Activity 7: The LP problem is solved. The solution is called the empty vehicle trip matrix.

Activity 8: The empty vehicle trip table is examined for validity and the fleet size requirements are determined.

Activity 9: Vehicle routing based on zone-to-zone and time period-to-time period movements is then converted to trip origin address to destination address movements with departure and arrival times specified.

Summary

This paper examined vehicle dispatching functions of a demand responsive transportation system for elderly and handicapped persons and proposed a method to optimize vehicle routing. The method yields the optimum vehicle travel sequence to mimimize empty vehicle travel and idle time. since the unproductive vehicle time is minimized, the derived fleet size is also minimal; thus it is useful not only for schedule preparation, but also for fleet size and driver size evaluation. The procedure is relatively simple to use and is easily computerized. The implementation of the proposed method would bring about energy and operating cost savings in the short run, and the capital cost savings in the long run.

Shinya Kikuchi, Assistant Professor, Department of Civil Engineering, University of Delaware, Newark, Delaware 19716.

SAFETY AND LONG-DISTANCE TRANSPORTATION FOR THE DISABLED

Bhagirath Lall

Introduction

This paper deals with the special problems encountered by the disabled in their travels on intercity buses. For the purpose of this paper, the needs of perhaps only a small percentage of the disabled persons have been addressed. However, their number may be quite large. The author claims no expertise in the types of disabilities or their causes. The paper addresses the needs of those individuals who are generally confined to a wheel chair, and may require some or little assistance in boarding or alighting from an intercity bus. Once on board they may be capable of looking after themselves and would require no assistance during the trip, which may last several hours. Family members, friends or volunteers are often available to provide needed assistance and a wheel chair at either end of the trip. It provides the disabled a sense of independence and frees them from the expense of an escort or companion during the trip. Some bus companies, of course, have offered to provide free travel for the companion in their escort service program. However, as the disabled are aware, the expense for the escort is not limited to the cost of a ticket alone. Requirement of an escort during the trip limits their ability to share those special few days in the year with friends or family, who might live a few hours away.

Bus companies have generally authorized the drivers to exercise full privilege in excluding a person from boarding if the driver feels that it would not be in the interest of "travel safety." This concept of "travel safety" is loosely defined and may imply concern for the safety of other passengers in case the disabled person was dislodged or ejected from the bus seat. The concerned driver has often argued that this may occur during an accident or while the vehicle negotiates a sharp curve or in circumstances of severe braking. The paper examines the forces exerted on a passenger during the travel in a vehicle. Miminum standards of geometric design are assumed to simulate adverse travel conditions that might subject the passenger to the severest forces. The paper provides justification for the requirement of seat belts for a limited number of seats in a bus. It provides even a stronger justification for requiring some rearward facing seats in the intercity buses. Both modifications can be made at a small cost.

Negotiating a Curve

It may generally be assumed that intercity bus drivers by and large adhere to the posted speed limits in their driving. There is ample justification for this assumption considering the safety record evidenced by their consistently low accident rate. During 1975 intercity buses were responsible for 0.012 fatalities per 100 million passenger miles as compared to 1.2 for the automobiles (U.S. Sec. of Transportation,). During 1978-80 the average death rate for intercity buses was 0.05, while it was 1.3 for passenger automobiles and taxis (NSC, 1982). Posted speed limits and operating speeds in turn are lower than the design speed which governs the geometric elements of the roadways. Thus, if minimum radii of curves based on Table 1 were provided on rural highways, the maximum coefficient of side friction that the passengers may be subjected to would be 0.16. It would still be nearly one-half the value (0.30) at which the passenger may experience sliding sideways and a sense of discomfort. All this goes on to establish that the occasions on which the passenger may experience discomfort or sliding during a ride are rare indeed, or infrequent at its worst. The author can personally vouchsafe to this from his experience of having logged 10,000 miles on intercity buses on all terrains in North America. The author does not recall a single incident when he may have had to hang on to the seat in front to keep his balance or when he may have had to apologize to a fellow passenger for sliding into him/her. That is obviously far from being ejected from the seat. Incidentally, the author did spend quite a few nights sound asleep during these cross country rides. A person asleep is no less vulnerable than a disabled person when it comes to retaining control, poise and balance under the effect of forces during a ride.

Figure 1 represents side-friction factors for rural highways and higher speed urban streets based on AASHTO policy (AASHTO, 1979). Figure 2 provides side-friction factors for lower speed urban streets and Figure 3 indicates a relation between speed and side-friction factor on curves at intersections based on the same AASHTO policy. Higher side friction factors are allowed in the design at intersections as curves at these locations are not considered in the same category as on the open highway because of the various warning signs provided. Also the anticipation by the driver of more critical conditions at an intersection permits the use of less conservative design factors. However, it is generally clear that higher range of side-friction factors are associated with low speed and much lower values are employed in association with greater highway speeds on

TABLE 1

Superelevation (e)		*Radius of Curve (ft.) for Design Speed*	
		50mph	*30mph*
0.06	Desirable for rural highways with snow and ice. Maximum for downtown arterials.	849	273
0.08	Maximum for rural highways with snow and ice and for rural arterials.	764	249
0.10	Maximum for rural and Suburban highways.	649	229
	Coefficient of side friction (f)	.14	0.16

SOURCE: AASHTO: A Policy on Geometric Design

curves. Passengers in the bus, of course, may or may not always become aware of the change from rural to urban conditions as much as the driver since they are not concerned with the driving task. In fact, they may quite be preoccupied with other activities namely reading, conversation or thinking. Passengers, thus, may perhaps experience a little sway near intersections, but no worse. For them to feel discomfort associated with sliding along the seat, the driver would have to be travelling at 64 miles per hour over a curve which is properly designed for 50 miles per hour. Those conditions are rare, if they ever occur at all. As is suggested later in the paper, if the concern about an individual's ability to support oneself or remain in seat is in question, then a seat belt could be of paramount importance.

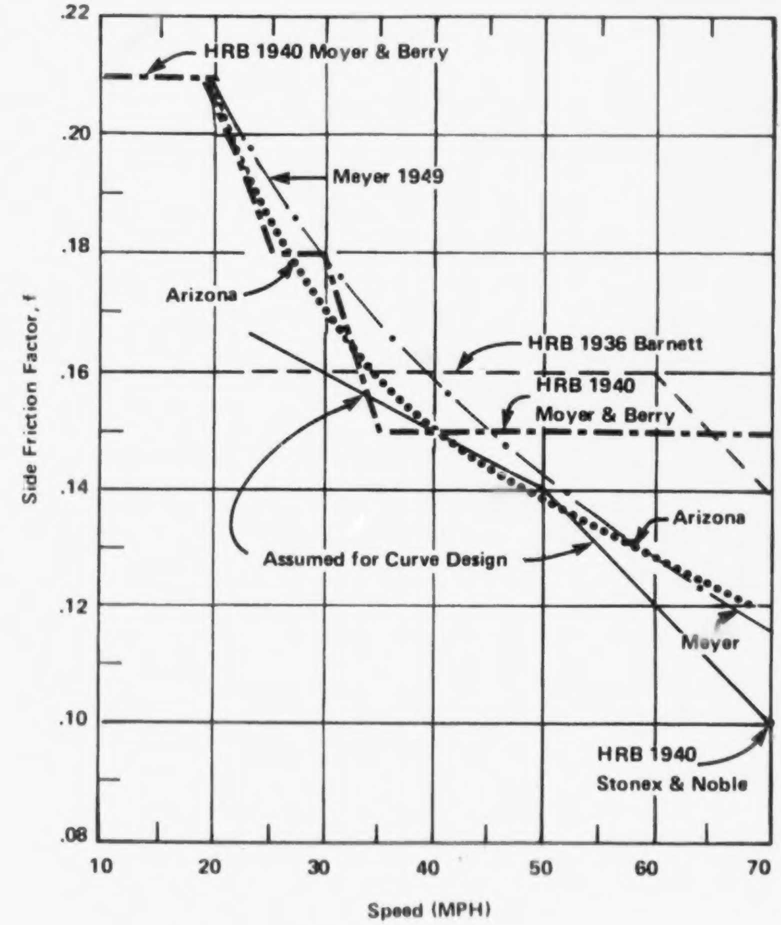


FIGURE 1

Side Friction Factors for Rural Highways and Higher Speed Urban Streets.

SOURCE: AASHTO: A Policy on Geometric Design

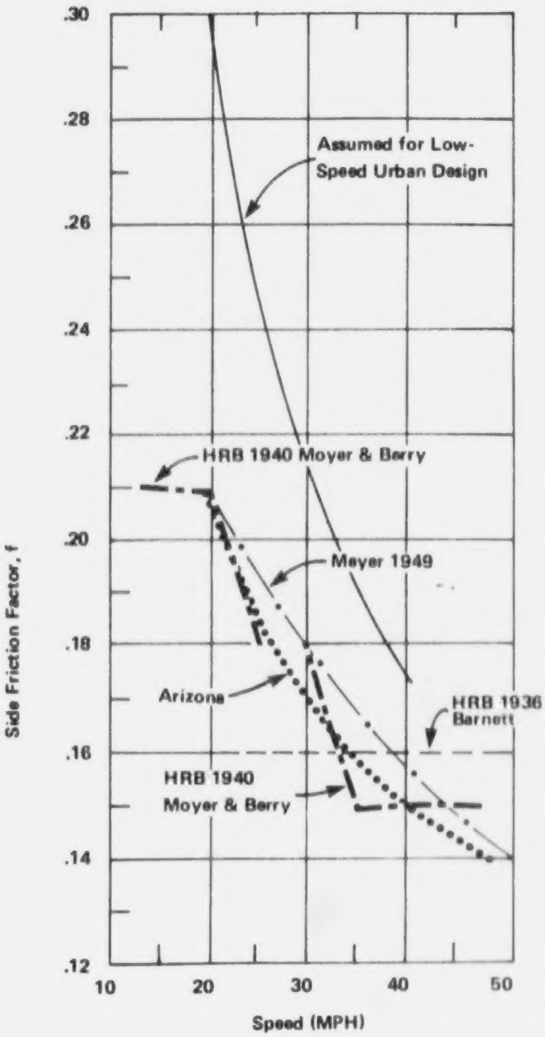


FIGURE 2

Side Friction Factors for Lower Speed Urban Streets.

SOURCE: AASHTO: A Policy on Geometric Design

Circumstances of Severe Braking

Severe braking of the vehicle subjects the passengers to perhaps the largest force during travel except in the case of an accident. Braking to stop a vehicle from 50 miles per hour on dry pavement can subject the passenger to a deceleration of approximately 19 ft/sec^2 or 0.60g. It has been reported that deceleration rates of 7.0 to 13.9 ft/sec^2 (or 0.22 g to 0.43g) occur on approaches to intersections based on an evaluation of driver behavior at signalized intersections (Wortman and Mathias, 1983). During an accident, particularly a head on collision, the passenger could be subjected to a deceleration rate of 20g if the vehicle were to have its motion arrested in about 4 feet travelling at 50 miles per hour (HMSO, 1963). On the other hand, if the vehicle was to stop within 2 feet after hitting a tree or an abutment, the passenger would experience a force of 40g. A simple way of stating this is that a person traveling in a vehicle would experience a force equal to his own weight or less during severe braking, but could be subjected to a force equaling 20 to 40 times his weight during a collision. It is generally accepted that the human body can withstand deceleration of up to 20g without serious injury. These findings are reportedly based on experiments carried out on human subjects and the examination of victims of accidental falls and the like (HMSO, 1963). It is perhaps this research which has lead to no requirements for seat belts in buses. A few school districts in the country are currently beginning to require seat belts for all passengers and are ordering their fleet to be modified. We have been aware of the usefulness of passenger restraint systems for years. There is finally a revived enthusiasm and some states have adopted enforcement of seat belt wearing laws.

What is now being considered normal for all passengers in private vehicles, and some public vehicles, at least in some states, is, of course, of paramount importance for the handicapped and the disabled. A passenger restraint system for them is not only essential for their safety during travel, but provides freedom and a worry free environment, with which they can independently cope. Bus companies have indicated that the added cost of providing seat belts for all passengers is prohibitive. But they have also stated that their safety record ensures that there are rare instances, if any, when a seat belt serves a useful purpose for the passengers. Perhaps they are right, as intercity bus service has proved to be one of the safest modes of transport over the years. However, the issue assumes a different light for the disabled individual. A passenger restraint system may not be required for all passengers in intercity buses, but it is an essential item for the disabled even when escorted by a companion. A strong justification can be made for the provision of seat belts at least along one row of seats. It can provide the choice of a restraint system to those who so desire, whether disabled or not, but above all, will provide up to four seats, when required, for the exclusive use of the disabled. The cost should not be prohibitive under the circumstances, and in fact, could be greatly reduced when seat belts are installed during the manufacturing stage.

Rearward Facing Seats

The most important innovation of all, of course, would be to install some seats facing rearward in the vehicle. Even without a seat belt, the passenger would be pushed into the seat rather than being ejected forward from it during severe braking. As discussed earlier, severe brak-

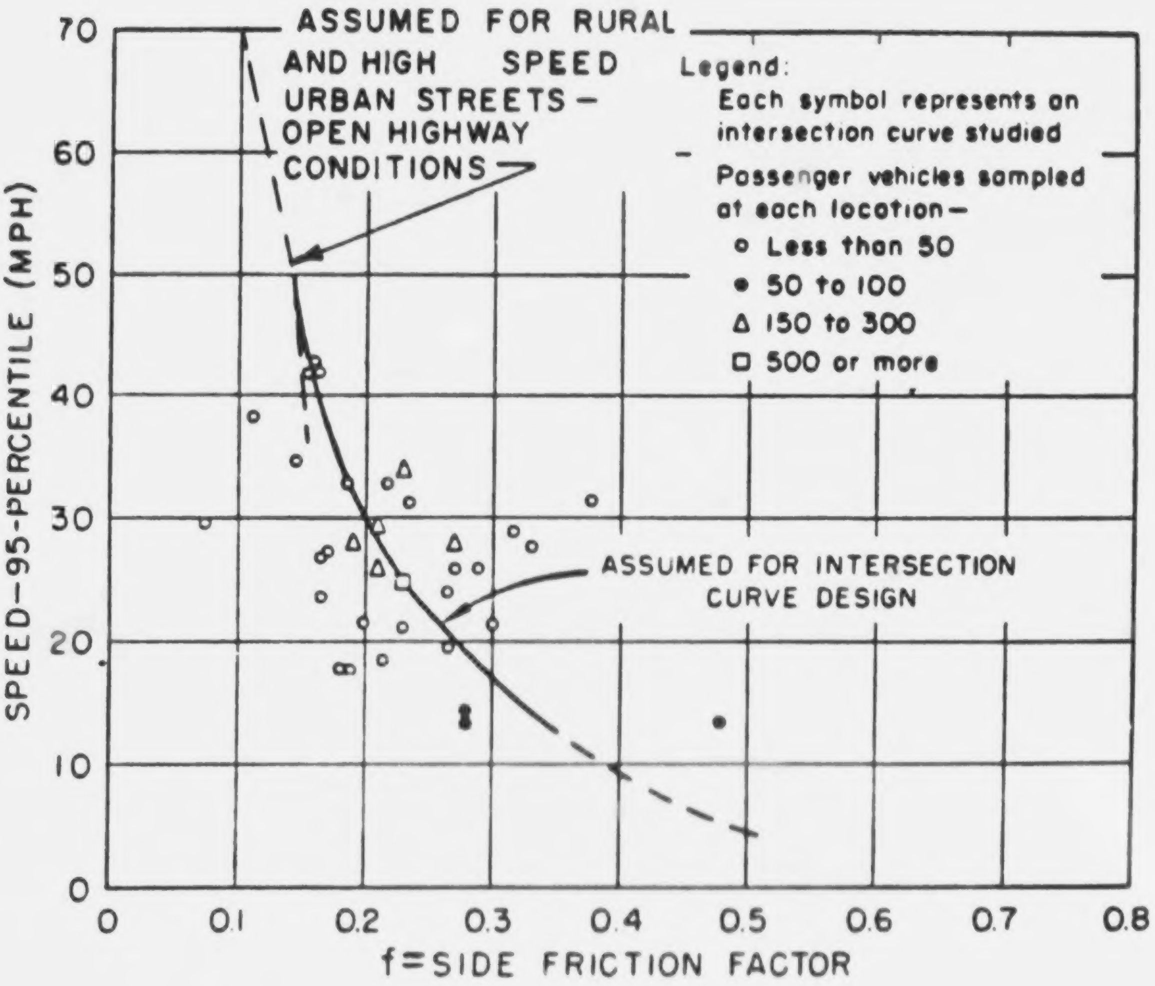


FIGURE 3

Relation between Speed and Side Friction Factor
on Curves at Intersections.

SOURCE: AASHTO: A Policy on Geometric Design

ing causes perhaps the largest forces on the passenger other than during a collison. The Code of Federal Regulation is surprisingly silent on the issue of whether to provide rearward facing or forward facing seats on buses.

It certainly specifies performance standards for rearward facing seats as it does for the forward facing seats. An inquiry from the office of the National Highway Traffic Safety Administration reveals that the Code (49CFR) is aimed at specifying performance standards. It is not for them to suggest innovations in seating arrangements. If the manufacturers choose to include rearward facing seats as part of the design, the performance standards are specified.

And why are manufacturers or bus companies not requiring rearward facing seats? In response to this question, the bus companies state that they are meeting the regulations and by-laws of the federal and state governments and see no need to suggest any changes in the seating arrangements. Therin lies the predicament. Providing rearward facing seats may seem anomalous to most, but it would be a boon to the disabled, and of substantiated benefit to all passengers. Seats have generally been placed facing forward as the driver does. No distinct advantage was seen in the rearward facing seats initially and thus it became conventional to provide forward facing seats. This trend has been generally maintained even though public transport vehicles in Europe have occasionally both forward and rearfacing seats in groups. It provides a friendly environment for persons traveling together or for strangers to get acquainted. It is ideal for families traveling with children. A strong recommendation is made to provide at least a small group of seats facing rearward on the intercity buses. It is an innovation which calls for no additional costs when included as part of the design at the manufacturing stage.

References

American Association of State Highways and Transportation Officials (AASHTO), "A Policy on Geometric Design of Highways and Streets," Washington, D.C. NCHRP Project #20-7, Task 14, Revised Draft #2, December 1979.

Her Majesty's Stationery Office, "Research on Road Safety," London, England, 1963.

Office of the Federal Register, "Code of Federal Regulations," 49CFR, Superintendant of Documents, U.S. Govt. Printing Office, Washington, D.C.

National Safety Council, "Accident Facts," Chicago, 1982.

U.S. Secretary of Transportation, "National Transportation Trends and Choices (To the Year 2000)," Superintendant of Documents, U.S. Govt. Printing Office, Washington, D.C.

Wortman, R.H. and Mathias J.S., "Evaluation of Driver Behavior at Signalized Intersections," Transportation Research Board, Washington, D.C., No. 905, 1983.

Bhagirath Lall, Associate Professor of Civil Engineering, Portland State University, Portland, Oregon, 97207.

317

A MODEL OF PARATRANSIT DEMAND AND SUPPLY

David L. Lewis

Introduction

Setting up and operating a specialized service for the handicapped involves an array of difficult decisions and trade-offs. For example, planners must decide whether to serve only severely disabled persons—those for whom regular transit is physically impossible to use—or to extend eligibility to moderately handicapped and able-bodied elderly persons as well; they must delimit the geographic range of service and the network of available destinations within that range; and service levels must be established, such as advance booking requirements and fares.

Such decisions inevitably involve trade-offs and it is trade-offs of this kind that usually define the planner's forecasting needs. For example, if a locality decides to offer same-day service rather than require a 24-hour advance reservation, the planner must forecast whether the added cost would exceed the available budget. If so, he or she must examine potential areas for reducing costs, such as tighter eligibility rastrictions, and forecast their possible implications.

Proposed U.S. Department of Transportation regulations could further reinforce the need for this kind of "trade-offs forecasting" in the 1980's,[1] and a number of States have enacted similar legislative requirements. The proposed DOT regulations establish six minimum service criteria for specialized transportation and introduce the concept of a cost cap that determines the maximum amount a locality would need to spend in providing service. Were a locality unable to meet all six criteria within the cost cap, it could, at its discretion, make trade-offs among all six aspects of service until costs fall within an acceptable range.[2]

Through lack of any means to forecast the impacts of different levels of specialized transportation for the handicapped, planners have turned to "on-the-street" experiments, demonstration projects, and plain trial-and error. Though necessary, such techniques are costly and time-consuming and can prove divisive by changing consumer expectations should it be necessary to shift ground again after the experimental period. Out of recent experience, however, there has emerged a sizeable database of systems and their operating characteristics under a range of service levels.[3] Based on statistical analysis of this database, a model has been developed that enables a locality to forecast the demand and cost characteristics of door-to-door services for disabled persons under a wide range of alternative service levels. This paper describes the model and demonstrates its use.

Regulatory Background

Although the proposed regulations described here are not yet in force and could change before final publication, they represent a useful example of the kind of problem the model is designed to solve.

On September 8, 1983 the Department of Transportation proposed the new regulations[4] to guide local transit operators in complying with the requirements of Section 504 of the Rehabilitation Act of 1973[5] and other legislative mandates. The regulations specify transportation options that would meet the requirements of Section 504; they specify minimum criteria governing the level and quality of service; and they set a cost cap that would define operators' financial responsibility in complying with the minimum criteria.

The proposed regulations would allow localities to select their own approach to serving the transportation needs of disabled persons from a range of permissable alternatives. These are:

- 50 percent of the fixed route bus fleet with wheelchair lifts. In pursuing this approach, the transit authority would have to ensure that half of the buses it operates during peak and off-peak periods are lift-equipped for wheelchair users.

---

[1] See Federal Register, September 8, 1983, 48 FR 40684. The proposed regulations were still in the public comment period at the time of this writing.

[2] A locality could, if it chose to, spend more than the upper limit. See 48 FR 40684. The six criteria in the proposed final regulation are, fares comparable to local transit fares; "reasonable" advance request times; no trip purpose restrictions; geographic range of service comparable to local transit service; no waiting lists; and same days and hours of service as local transit.

[3] The data covering 53 systems, were compiled by the Urban Mass Transportation Administration for the years 1979-1980. The data is to be published in 1985.

[4] op cit. 48 FR 40684.

[5] Section 504 states that: "no otherwise qualified handicapped individual in the United States shall, solely by reason of his handicap, be excluded from the participation in, be denied the benefits of, or be subjected to discrimination under any program or activity receiving federal financial assistance." Public Law 93-112, 93d Congress, HR 8070, September 26, 1973.

- Specialized paratransit service. According to regulations, such a system would provide demand-responsive service by means of lift-equipped vans operated by the transit authority or subsidized taxi vouchers. Eligibility would extend, at a minimum, to handicapped and elderly persons who "physically cannot use public transportation".
- A mix of fixed route and paratransit service. Under this approach, the transit operator might, for example, adapt fewer than half the buses with wheelchair lifts (say, 15 percent or 25 percent) while using paratransit service to cover parts of the city not serviced by lift-equipped buses.

Other combinations would also be permissible.

Transit systems that opt to provide specialized demand responsive transportation, the focus of this paper, would need to meet six minimum service criteria, although only if doing so would not cost more than the specified cost cap. The criteria state that:

- Service shall be available to handicapped persons throughout the same general service area as that served by the regular route systems;
- Service shall be available on the same days and during the same hours as the regular route service;
- The fare for a handicapped person using the specialized service shall be comparable to the fare for the regular route service;
- Advance request time must be limited to a "reasonable time", where "reasonableness" would be determined by the transit operator, after obtaining the views of handicapped persons through a process of public participation.
- Service shall be available for all trip purposes;
- Waiting lists of persons eligible to use the service cannot be established; rather, all eligible users wishing to use the specialized systems must be permitted to do so.

Where a locality cannot meet all six criteria within the cost cap, it can, at its discretion, make trade-offs among the six criteria until costs fall to that level. Two possible cost cap options are defined in the proposed regulation. These are:

- 7.1 percent of the average annual federal assistance received by the local transit authority over the current and previous two fiscal years; and
- 3.0 percent of the transit authority's operating expenses over the current and previous two fiscal years.

Paratransit Costs, Service Levels, and Cost Caps

The Model: A Tool for Local Planners

An econometric forecasting model—based on actual operating data from 53 cities with paratransit service—used was as a basis for developing paratransit costs under alternative types of operation (user-side subsidy versus transit operated services) and alternative levels of service and fares.

Based on service and fare levels specified by the local planner, the model produces a range of forecasts, such as demand (annual trips), productivity (trips per vehicle hour), cost per trip, fleet and driver requirements, total annual cost and revenue from fares. The model operates with any micro-computer and requires no knowledge of computer programming. The user specifies the following details about the system:

- whether the system will be based on the user side subsidies or provider-side approach;
- fare level;
- whether vehicles will be lift-equipped;
- whether eligibility will be available to all handicapped and elderly persons or only to the severely disabled (those least likely to be capable of using regular transit);
- whether a 24 hour advance reservation will be needed to use the service or whether transportation will be available on shorter notice;
- whether the service will be restricted to a geographic area smaller than that served by the regular transit system or whether the entire geographic area will be served; and
- whether only limited destinations (trip purposes) in the service area will be served—such as bus terminals and hospitals—or whether passengers may choose any destination or trip purpose.

The model thus allows for variation in many of the key service criteria listed in the proposed DOT regulations and of key interest to planners generally. The model also allows for variation in urban size, residential density, and vehicle utilization, and it is thus suitable for analyzing the likely impacts of the proposed regulations in different sized cities.

The approach used in this paper is to estimate the operating-plus-capital costs of running a paratransit system in the average sized city in each of four population categories, (see Table 1 for a description of the four population groups). This approach is used for convenience only. The model could just as easily be applied for any specific urban area. The analysis excludes the nation's six largest cities (see Table 1) since their inclusion would substantially distort the analysis for other cities. This is because historically these six cities have received fully 53 percent of all federal transit assistance.[6]

---

[6] See U.S. House of Representatives, Committee on Public Works and Transportation, Ovesight of the Federal Public Transportation Assistance Program, May 1982.

TABLE 1

The Average Sized Cities in Four Population Categories

Population Category	*Number of Urbanized Areas*	*Average Population Size*
Less than 250,000	197	118,086
250,000—500,000	35	356,542
500,000—1 million	22	692,732
1 million or more (excluding New York, Los Angeles, Chicago, Philadelphia, San Francisco & Boston.	19	1,573,328

Source: Census of Population

In practice, of course, costs will vary from city to city depending upon local wage rates and other factors (e.g., population density). For analytic purposes such expenses are assumed to be $23.00 per vehicle-hour, the average (in 1983 dollars) drawn from the database for systems that are operated by transit authorities Taxis used under a user-side subsidy approach are assumed to cost $5.60 per trip[7] including costs for program administration.[8]

The Cost of Individual Service Attributes

Annual paratransit costs vary substantially with shifts in service quality. Based on the econometric model, Table 2 displays the estimated cost of providing a very restricted "minimal" paratransit service—one in which trip purposes are constrained, only part of the geographic area is served, advance reservation of 24 hours or more is required, and other restrictions are in force. The Table then shows the estimated impact of removing each restriction—not cumulatively, but rather the effect of each restriction singly on the "minimal" system. Table 3 which summarizes Table 2, shows the percentage increase in annual cost estimated to result from the removal of each restriction on the "minimal" system. The largest

Table 2

Annual capital and operating costs for the average sized city in each population category to operate a low-quality, highly restricted paratransit system: and the incremental costs for selected service improvements

(in thousands of 1983 dollars)

	Under 250,000	*250,000 - 500,000*	*500,000 - 1,000,000*	*Over 1,000,000*
Minimal System[1]	159	245	317	491
Incremental Costs to:				
Remove 24 Hour Reservation from Minimal System	+ 104	+ 166	+ 214	+ 334
Remove Geographic Area Restriction from Minimal System	+ 70	+ 108	+ 135	+ 212
Remove Destination/ Trip Purpose Restriction from Minimal System	+ 92	+ 124	+ 184	+ 290
Remove Restrictions on Days and Hours of Service from Minimal System A (see text discussion)	N/A	N/A	N/A	N/A
Eliminate Waiting List (if any—see text A (discussion)	N/A	N/A	N/A	N/A
Extended Eligibility to all ransportation Handicapped Persons	+ 80	+ 163	+ 198	+ 327

SOURCE: Paratransit model

1. The following service attributes are assumed for the hypothetical "minimal" system:

- Eligibility is restricted to several disabled persons;
- Subscription service is required for recurring journeys;
- Advance reservation of 24 hours or more is required;
- Destinations and trip purposes are restricted;
- Geographic range of service is restricted;

Notes: Operating costs per vehicle hour are assumed to be $23.00. The annual costs shown in the Table include both operating expenses and the depreciated capital costs for vehicles.

The incremental costs shown are not cumulative.

Cumulative costs are shown in section 3.

N/A = Not Available

"Severely disabled" means unable to use the regular route system.

"Transportation handicapped" includes persons able to use the regular Route system with difficulty.

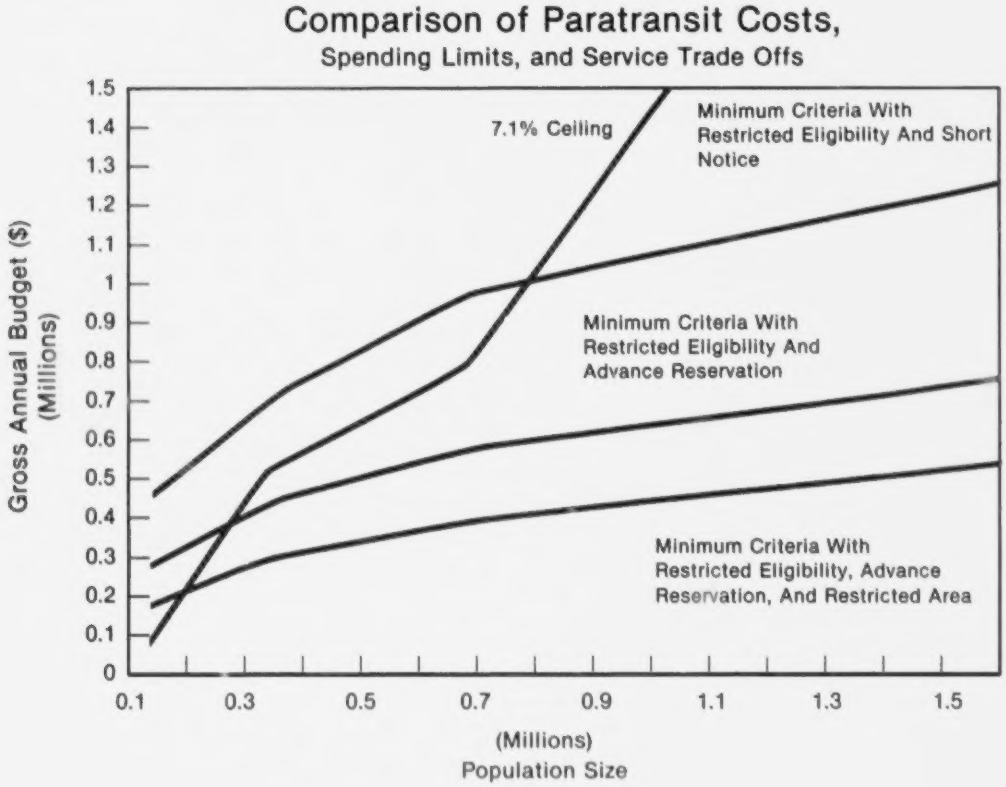
---

[7] This figure is drawn from Peat, Marwick, Mitchell & Co., Final Report CRW Model Review, (Report Prepared for the Urban Mass Transportation Administration), November 13, 1978—updated for inflation at 10% per annum. This adjustment results in costs consistent with recent (1983) findings of the International Taxicab Association, (from Interview with ITA, August 1984).

[8] Note that cost-per-trip for transit-operated systems hinges upon their productivity (trips per vehicle-hour). If for example productivity is 2.0 trips per vehicle-hour (a typical figure), transit-operated demand response service would cost $11.50 per trip ($23.00/2.0) as compared with $5.60 for taxis. The model estimates productivity for transit-operated systems and combines this with cost per vehicle-hour projections to derive cost per trip. For taxi systems under contract, the model uses cost par trip estimates directly.

FIGURE 1

Gross Annual Paratransit and User-Side Subsidy Costs
(Paratransit costs @ $23.00 per vehicle-hour;
User-side subsidy costs at $5.60 per trip)



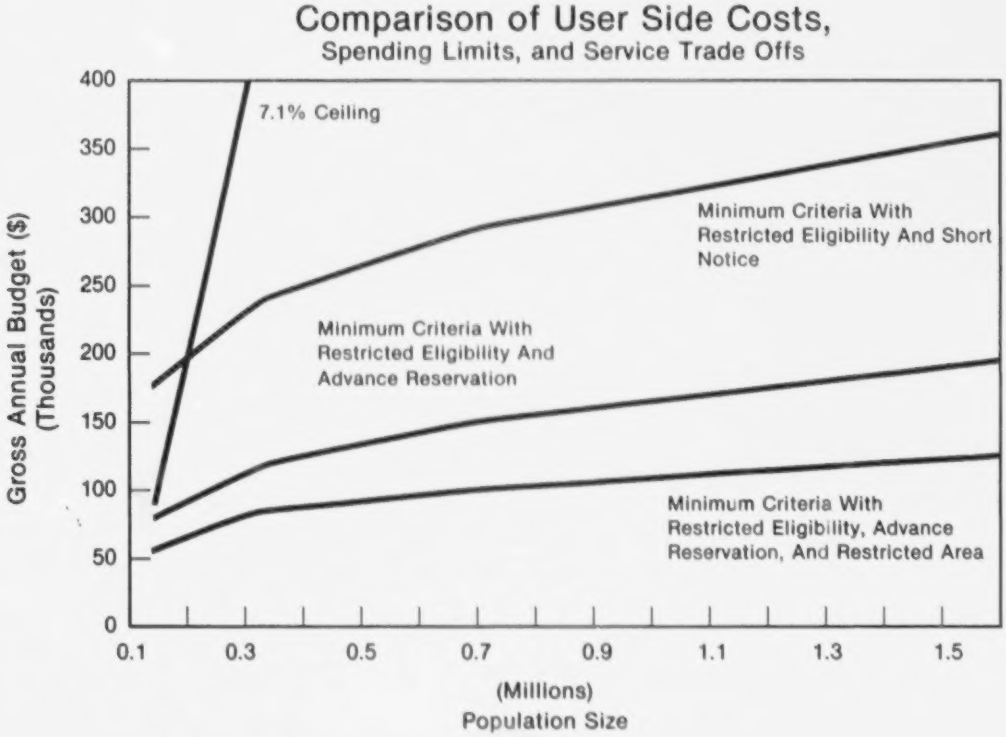
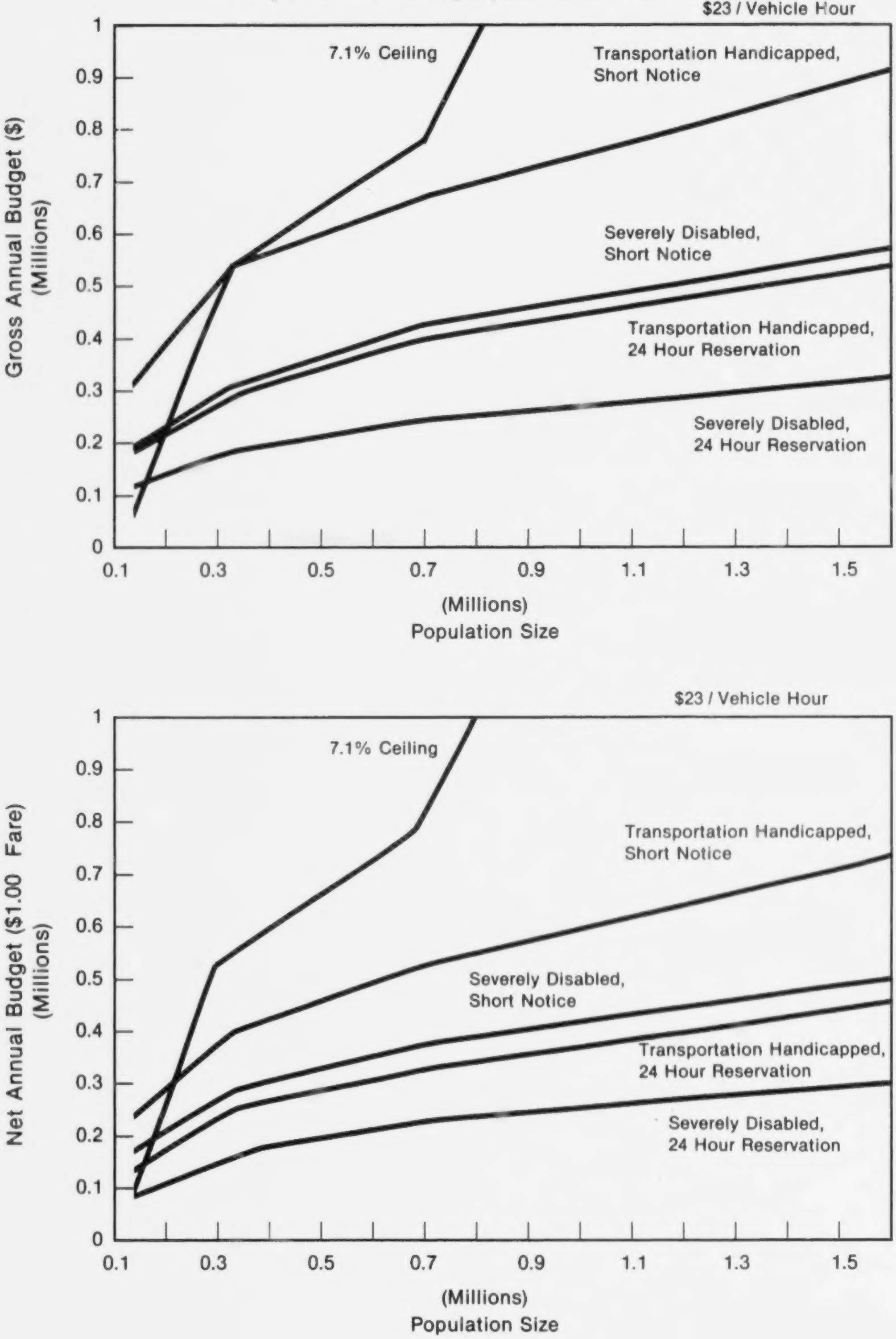


FIGURE 2

Gross And Net Annual Costs For Paratransit With Trip Purpose and Geographic Area Restrictions



impact stems from the removal of the 24-hour advance reservation requirement; this alone increases annual cost by nearly 70 percent. Other cost impacts range from 40 percent to 63 percent higher spending requirements, as shown in Table 3.

The need to make trade-offs among various service levels would be governed to a large extent by budgetary constraints. Although some cities might decide to meet certain service criteria regardless of cost, for others the service level provided will hinge on such budgetary constraints. Cities must compute their spending budgets locally; service levels can then be analyzed accordingly, as shown next.

Table 3

Cost Impact of Shifts in Service Quality

Change in Service Quality	*Percentage Impact on Annual Cost (Average Across all City Sizes)*	
	Average Impact	*Range Based One Standard Deviation*
Remove 24 Hour Advance Reservation	+68	+35 to +109
Remove Geographic Area Restriction	+43	+26 to +63
Remove Destination/ Trip Purpose Restriction	+37	+39 to +82
Extend Eligibility to all Transportation Handicapped	+61	+31 to +98

SOURCE: Estimates in Table 2.

TRADE-OFFS PLANNING ANALYSIS

Based on the econometric model, Figures 1 and 2 display estimate annual budgetary requirements for several alternative system designs. The analysis, shown for a range of city sizes, reflects the costs associated with operations under the direct involvement of the transit operator and those where service is delivered by private taxi companies under contract (so-called user-side subsidies). All estimates reflect average estimated impacts of each service attribute (see Table 3) and average hourly costs. A more detailed use of the model would involve a risk analysis based upon standard errors for each attribute, for hourly vehicle costs, and for taxi per-trip costs.

Some key findings from the analysis are outlined below:

- For a given budget, many different service level combinations are available (see both Figures). These planners will thus need to compare budgetary constraints with the costs of a wide range of alternatives. Together with disabled residents, priorities can be assigned to individual service attributes in order to generate the locally preferred approach;
- User-side subsidy techniques cost less (compare Figure 1 top and bottom.) Based on the model analysis, a given service package can be provided at about half the costs of the transit-operated service if user-side subsidy techniques are applied. Some cities would find this approach difficult however because of labor requirement under federal legislation and the need for special vehicles that taxi companies may not operate.
- Systems with broadly-based eligibility standards and 24-hour advance notice requirements cost roughly the same as short-notice demand-response service with restricted eligibility (everything else being equal) (see Figure 2.). In cities unable to provide both broad eligibility and short-notice service, a key choice may be that of restricting eligibility to certain groups and providing short-notice service; or requiring 24-hour or more advance notice service but offering specialized transportation to a wider range of handicapped individuals.
- Increased fares help proportionately little to offset gross costs, (compare Figure 2 top and bottom). Local planners may find it impossible to "buy" substantially better service levels for paratransit with revenue from fares (assuming fares to be about the same as regular transit fares) since potential revenues appear small relative to the costs of each service improvement.

Conclusion

In summary this paper describes a model that forecasts costs under a range of service levels. The examples given hold for localities with average populations and wage costs. Results will thus vary substantially in individual localities.

The lower portion of Figure 1 suggests that use-side subsidies—at an average per-trip cost of $5.60 (the aproximate national average for 1983), would permit all cities to meet the minimum criteria if reasonable advance reservation could be interpreted to mean 24-hour service. Of course, cities might elect not to use user-side techniques, or might find it impossible to do so for institutional reasons, (some cities find that Section 13(c) labor requirements are a barrier to the use of user-side subsidies). Also, many cities might find it necessary to cntinue some transit-operated paratransit, at least for persons who need lift-equipped service.

Nevertheless, comparing the top and bottom parts of Figure 1 indicates that combination of transit-operated and user-side subsidies would enable many—though not all—cities to meet the minimum criteria within the 7.1 percent cap if reasonable request time means 24-hour service. And even more cities could do so with geographic area restrictions.

Note: For copies of the methodology on construction of the Model and computer estimation procedure, contact the author directly.

Acknowledgement

Mark S. Munday assisted with the analysis in this paper and provided invaluable programming assistance in designing the computer model. Christina van Embden was instrumental during early stages of model development.

David L. Lewis is an Associate Partner, James F. Hickling Ltd., 350 Sparks Street, Ottawa, Ontario, Canada K1R 7S8.

SPECIAL NEEDS IN PUBLIC TRANSPORTATION IN CANADA: SOME SURVEY RESULTS

Mara Lee McLaren and Marion S. Fleming

Background

Over the past decade, a combination of events have caused a reappraisal of transportation legislation relating to the disabled in Canada. External events include the enactment of the Rehabilitation Act by the United States Congress in 1973, and the United Nations declaration of 1981 as the Year of the Disabled which focused world attention on the needs and rights of the disabled. Within Canada there have been several government-sponsored open meetings convassing people for opinions and suggestions relating to the needs of the disabled. Other factors have been the passing of the Canadian Charter of Rights and Freedoms in 1982, and amendments to the Canadian Human Rights Act in 1983 which further strengthened the rights of the disabled, and which introduced the concepts of accessibility standards and adaptibility plans.

The Canadian Transport Commission is involved in the development of accessibility standards for transportation modes under federal jurisdiction: namely, air, rail and, to some extent, inter-city bus.

In developing standards, it is important that one understand the current problems and barriers to full access, and know the numbers of people who might benefit from proposed changes in order that responsible decisions can be made which will balance different needs and solutions, together with the costs and the benefits to be gained. While some estimates exist concerning the numbers of people with various kinds of transportation-related disabilities, these have not been particularly satisfactory for our purposes. Some have been based on American statistics, or were drawn from small regions of Canada, or covered only urban centres, or asked questions which are not relevant to transportation disabilities.. For example, the Data Based study for the Identification and Quantification of Transportation Handicapped Persons in Canada (1979) was based on U.S. survey results from urban areas obtained by the Urban Mass Transportation Administration (UMTA) of the U.S. Department of Transportation. Another study, The Sociodemographic and Need Related Characteristics of the Physically Handicapped in Ontario (1981) surveyed only the Province of Ontario. The Canada Health survey (1981) was nationwide, but focused on questions concerning the ability to do certain activities, and the activities covered unfortunately do not allow for accurate translation into statistics on transportation related disabilities. A fourth source, the Data Handbook on Disabled Persons in Canada (1982), combined results from the Canada Health Survey with other sources, including the 1981 studies sited above. In addition, none looked at the types of transportation problems encountered by disabled persons using intercity modes of transport.

Thus a fresh survey entitled "Special Needs in Public Transportation" was undertaken in August 1983, sponsored jointly by the Canadian Transport Commission and Statistics Canada, with the goals of determining: 1. The size of the handicapped community, by various types of transportation disability. 2. The forms of assistance required by transportation disabled persons when travelling by air, rail, and intercity bus. 3. The problems and barriers they encounter when travelling.

Survey Methodology

The Special Needs in Public Transportation Survey was conducted in August 1983 as a supplement to the Labour Force Survey (LFS). The LFS samples residents of Canada 15 years of age and over from the 10 provinces. It excludes those living in the Yukon and Northwest Territories, Indian Reserves and Crown Lands, inmates of institutions, and members of the Armed Forces, who together total about 2 percent of the total population of Canada. A detailed description of the methodology for the LFS can be found in the Statistics Canada Catalogue 71-526 (Occasional) entitled "Methodology of the Canadian Labour Force Survey", 1976.

The omissions are unfortunate as they leave out several groups of special interest—children, natives, those of the Far North, and in particular those living in institutions where one might expect, a priori, a significant proportion of the disabled live. However, the LFS is such a fast, efficient, and economical vehicle for collecting data that it was felt its advantages more than outweighed its disadvantages.

A copy of the six survey questions (renumbered here for convenience), that were attached to the LFS, appear in Figure 1. These were attached to two segments or rotations groups out of the six which comprise the full LFS. This resulted in a sample size of approximately 18,000 households or 39,000 individuals.

The number presented in the sections to follow are projections of the survey results to the Canadian "target" population; that is, those aged 15 years and over living

Figure 1

1. DO YOU HAVE ANY PHYSICAL CONDITION OR HEALTH PROBLEM WHICH MAKES IT DIFFICULT FOR YOU TO TRAVEL WITHOUT SOME FORM OF ASSISTANCE OR AID? *(e.g., wheelchair, cane, attendant assistance)*

Yes 1 ○ No 2 ○ END

2. IS YOUR PHYSICAL CONDITION OR HEALTH PROBLEM RELATED TO ANY OF THE FOLLOWING?

	Yes	No
Seeing	1 ○	2 ○
Hearing	3 ○	4 ○
Mobility	5 ○	6 ○
Other *(specify in NOTES)*	7 ○	8 ○

3 ARE YOU PREVENTED FROM USING ANY OF THESE FORMS OF TRANSPORTATION BECAUSE OF YOUR PHYSICAL CONDITION OR HEALTH PROBLEM?

	Yes		No
Airplane	1 ○	If all 'Yes' END	2 ○
Train	3 ○		4 ○
Bus excluding city bus	5 ○		6 ○

4 SINCE THE ONSET OF YOUR PHYSICAL CONDITION OR HEALTH PROBLEM, HAVE YOU USED ANY OF THE FOLLOWING FORMS OF TRANSPORTATION? *(Mark all that apply)*

Airplane	1 ○	Go to 14
Train	2 ○	
Bus excluding city bus	3 ○	
None of the above	4 ○	END

5 WHEN TRAVELLING ON AN AIRPLANE, TRAIN OR BUS, DID YOU ENCOUNTER DIFFICULTIES WITH ANY OF THE FOLLOWING? *(Mark all that apply)*

Hearing announcements	01 ○
Seeing signs, notices or announcements	02 ○
Going up and down stairs/escalators	03 ○
Moving about the terminal	04 ○
Boarding/disembarking	05 ○
Seating on board	06 ○
Washroom facilities	07 ○
Transporting wheelchair	08 ○
Transportation staff	09 ○
Carrier rules and regulations	10 ○
Other *(specify in NOTES)*	11 ○
None of the above	12 ○

6 WHICH OF THE FOLLOWING AIDS OR ASSISTANCE HAVE YOU USED WHEN TRAVELLING ON AN AIRPLANE, TRAIN OR BUS? *(Mark all that apply)*

Wheelchair owned by you	01 ○
Wheelchair provided by terminal or carrier	02 ○
Special assistance provided by staff	03 ○
Personal attendant accompanying you	04 ○
Manual or mechanical lift to board or disembark	05 ○
White cane	06 ○
Guide dog	07 ○
Walking aid *(cane, walker or crutches)*	08 ○
Other *(specify in NOTES)*	09 ○
None of the above	10 ○

in the 10 provinces, excluding those on reserves, crown lands, institutions, and the armed forces. It should be noted that these number are only estimates of the true number (or fraction, or percentage, as the case may be). It is possible, using statistical methods to estimate the level of uncertainty surrounding each number, in the sense that intervals or bounds can be determined around each value within which one can be sure, at some level of confidence, that the true value falls.

Statistics Canada guidelines require that estimates or values may only be presented in an unqualified fashion when the sample coefficient of variation (the standard deviation of the estimate divided by the estimate itself) of the estimate is less than 16.6 percent. If the coefficient of variation is between 16.6 percent and 25 percent the estimate may be presented if a warning is included, and if the coefficient of variation is greater than 25 percent the number may not be released at all. These guidelines are observed in this paper, which uses an asterisk (*) to denote a value with a coefficient of variation between 16.6 percent and 25 percent and a double asterisk (**) to replace a value with a coefficient of variation greater than 25 percent.

Survey Results

Type and Incidences of Disabilities

Question 1.—DO YOU HAVE ANY PHYSICAL CONDITION OR HEALTH PROBLEM WHICH MAKES IT DIFFICULT FOR YOU TO TRAVEL WITHOUT SOME FORM OF ASSISTANCE OR AID?

(e.g., wheelchair, cane, attendant assistance)

Yes	533,000	No	18,314,000

Out of a total target population of 18,848,000 people, over half a million, or 2.8 percent indicated they had some physical condition or health problem which made travel difficult without some form of assistance or aid. This percentage is lower than most percentage figures on the proportion of disabled persons coming from other sources. This result was to be expected, as the Special Needs Survey is interested in transportation related disabilities only, and in addition requires a respondent to admit to a limiting physical condition or health problem. It is well known by investigators under taking disability statistics research that respondents to surveys are often reluctant to admit to any kind of limiting disability or handicap.

Because of the known problems when dealing with self-reported disability data, it would be wise to treat the Special Needs incidence figures as lower bounds on the true proportion of transportation disabled individuals among the target population. That is, there may well be more disabled people, but it is unlikely there are any fewer.

Question 2.—IS YOUR PHYSICAL CONDITION OR HEALTH PROBLEM RELATED TO ANY OF THE FOLLOWING?

	Yes	*No*	*Not Stated*	*Total*
Seeing	108,000	247,000	179,000	533,000
Hearing	87,000	250,000	197,000	533,000
Mobility	379,000	69,000	85,000	533,000
Other	122,000	202,000	209,000	533,000

Of those who reported a problem with transportation in question 1, 71.1 percent indicated it was a mobility related problem, 20.2 percent indicated a seeing problem, and 16.3 percent indicated a hearing problem.

Reanalyzing in terms of percentages gives:

Type of Disability Reported	*Percentage of Total Target Population*	*Percentage of Disabled Population*
Seeing	.57	20.2
Hearing	.46	16.3
Mobility	2.01	71.1
Other	.65	22.9

The most common disability is one of mobility. This is reported more than three times as often as any other.

The "other" category is large, but is made up of a great many different kinds of disabilities. The two large subgroups in this category are mental disabilities and heart/circulatory problems, followed by major diseases which restrict ones ability to travel, arthritis, and respiratory problems, to name the larger subgroups. No subgroup is more than twenty percent of the total "other" group; consequently all are small relatively to the three major disability groups.

The number of people indicating more than one transportation related disability is available for the three major groups, and are represented in Figure 2.

These statistics show higher incidences of multiple disabilities than could be intuitively expected. For example, more than 70 percent of those with a hearing problem also have a sight or mobility problem, or both problems. About 60 percent of those with a seeing problem also have a hearing or mobility problem.

Transportation Diffculties and Needs of The Disabled Question

Question 3.—ARE YOU PREVENTED FROM USING ANY OF THESE FORMS OF TRANSPORTATION BECAUSE OF YOUR PHYSICAL CONDITION OR HEALTH PROBLEM?

	YES	*NO*
Airplane	210,000	282,000
Train	207,000	282,000
Bus excluding city bus	221,000	270,000

Thirty-nine percent of those answering yes to question one indicated they were prevented from using airplanes, thirty-nine percent were prevented from using trains, and 41 percent were prevented from using buses. In all, 36 percent or 190,000 people indicated they were prevented from using all three modes of travel because of their physical condition or health problem. Thirty-six thousand people did not reply to this question. This may reflect many who have never attempted to use any mode, and who thus do not know if they are prevented or not.

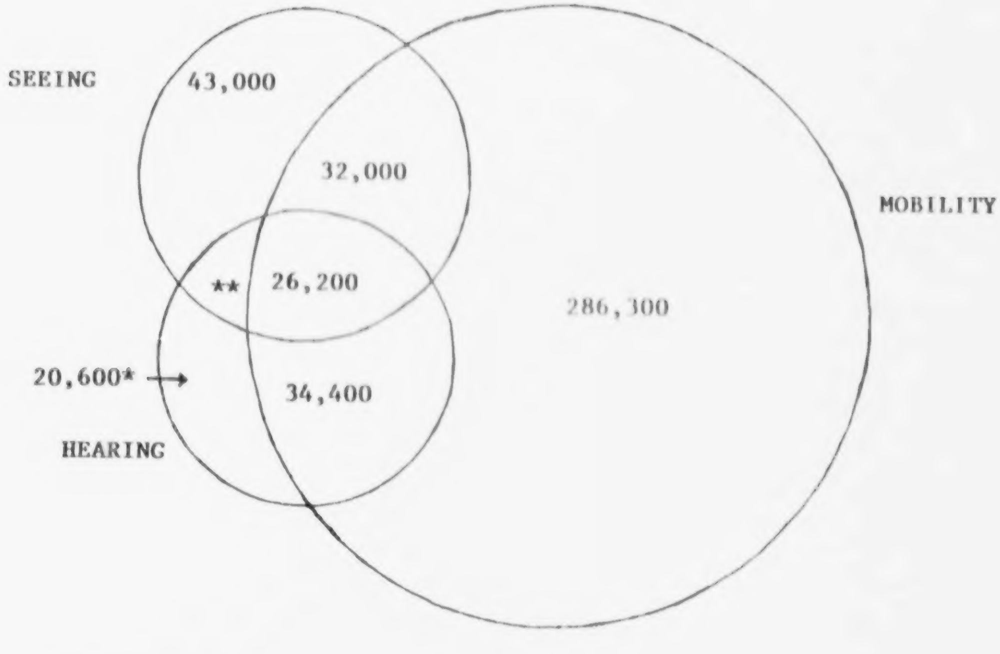
As 190,00 people indicated in question 3 that they were prevented from using all modes of transportation, their interviews were terminated; only 343,000 people were asked question 4. Of these, 30 percent have travelled by air, 12 percent by train, and 24 percent by intercity bus, while 52 percent indicated that they had used none of these and 23,000 people, or 7 percent, did not respond to question 4.

Question 4.—SINCE THE ONSET OF YOUR PHYSICAL CONDITION OR HEALTH PROBLEM, HAVE YOU USED ANY OF THE FOLLOWING FORMS OF TRANSPORTATION? (mark all that apply)

Airplane: 102,000
Train: 42,000
Bus excluding city bus: 81,000
None of the above: 177,000

A total of 140,000 people indicated in question 4 that they had used at least one mode of intercity transportation. Only these people were subsequently asked to respond to question 5 and 6.

Figure 2



* Coefficient of Variation greater than 16.6%.

** Coefficient of Variation greater than 25%.

Question 5.—WHEN TRAVELLING ON AN AIRPLANE, TRAIN OR BUS, DID YOU ENCOUNTER DIFFICULTIES WITH ANY OF THE FOLLOWING? (mark all that apply)

Hearing announcements: 21,000*
Seeing signs, notices or announcements: 25,000
Going up and down stairs/escalators: 89,000
Moving about the terminal: 66,000
Boarding/disembarking: 78,000
Seating on board: 23,000*
Washroom facilities: 24,000*
Transporting wheelchair: **
Transportation staff: 13,000**
Carrier rules and regulations:
Other **
None of the above: *

Of those indicating they have travelled (140,000), by far the most frequently encountered difficulties or barriers were stairs and escalators, (65 percent) boarding and disembarking (56 percent), and moving about terminals (47 percent).

Question 6.—WHICH OF THE FOLLOWING AIDS OR ASSISTANCE HAVE YOU USED WHEN TRAVELLING ON AN AIRPLANE, TRAIN OR BUS? (mark all that apply)

Wheelchair owned by you: 17,000*
Wheelchair provided by terminal or carrier: 31,000
Special assistance provided by staff: 58,000
Personal attendant accompanying you: 63,000
Manual or mechancial lift to board or disembark: 15,000*
White cane: **
Guide dog: **
Walking aid (cane, walker or crutches): 57,000
Other **
None of the above: 26,000

The most common form of assistance is to have a personal attendent, followed by having special assistance from staff. Many travellers also use a walking aid of some kind or use a carrier or terminal provided wheelchair.

Cross Tabulations

The simple tabulations of results from the survey are interesting in themselves, but of more use, perhaps, are such tabulations broken down by type of disability and/or mode of travel.

Table 1 lists the percentages of people within each major disability group who are (or perceive themselves to be) prevented from using each mode of travel.

TABLE 1

Prevented From Using (Percentage)

Disability	*Air*	*Train*	*Intercity Bus*	*All Three Modes*
Seeing	46	44	45	42
Hearing	49	44	48	44
Mobility	39	40	44	36

TABLE 2

Percentage Using Each Mode

Disability	*Air*	*Train*	*Intercity Bus*
Seeing	16*	**	14*
Hearing	16*	**	14*
Mobility	15	5*	11

TABLE 3

Percentage Mode Used

	Air	*Train*	*Intercity Bus*
Seeing Disability			
Seeing Signs	63	80	83
Stairs	71	65	53*
Moving about Terminal	58*	**	**
Boarding	60	56*	**
Hearing Disability			
Hearing Announcements	77	83	77
Stairs	49*	**	**
Moving about Terminal	45*	**	**
Boarding	52*	**	56*
Mobility Disability			
Stairs	72	91	75
Moving about Terminal	58	64	55
Boarding	63	71	69
Seating	18	**	19*
Washrooms	25	33*	21*

It would seem that the mobility impaired as a group consider themselves to be less restricted in their ability to use the various modes of public transportation than the other two groups. It should be noted that this conclusion is not statistically significant, because of the variability of these estimates. Similarly, from Table 2, which looks at actual travel by disability group, one might conclude, at least for air and bus modes, that the mobility impaired travel proportionately less than the other two groups. This again is not statistically significant.

The major difficulties encountered by those belonging to each disability group who have travelled by a particular mode appear in Table 3. The percentages reflect the number of people indicating that a particular difficulty was encountered, out of the total number who travelled by the indicated mode and who belonged to each disability group.

As one would expect, those with seeing disabilities had trouble with seeing signs, and those with hearing disabilities had trouble hearing announcements. Mobility related difficulties are greatest for those with mobility difficulties. However, both those with seeing disabilities and hearing disabilities experience difficulties with mobility-related barriers such as stairs, moving about a terminal, and boarding. Such problems do not seem as common for the hearing impaired as for the sight impaired although it is still large. This result may reflect the large number of respondents who are mobility impaired, and also have a seeing or hearing disability.

The major forms of assistance or aids used by those belonging to each disability group who have travelled by a particular mode are listed in Table 4.

TABLE 4

Percentage Mode Used

	Air	*Train*	*Intercity Bus*
Seeing Disability			
Special Assistance	49*	**	44*
Personal Attendant	46*	**	42*
Hearing Disability			
Special Assistance	55*	**	**
Personal Attendant	51*	**	57*
Mobility Disability			
Wheelchair owned	16*	**	**
Wheelchair provided	32	**	**
Special Assistance	48	44*	44
Personal Attendant	46	56	48
Walking Aid	45	52	53

Personal attendants, or special assistance from carrier personnel are the most frequently used aid in travelling for all three disability groups, for all modes travel.

It should be noted that travelling with a personal attendant does not mean that the attendant was required for medical reasons, on the insistance of the carrier, or for any other reason, except that respondents, in replying to the question, indicated that they had a personal attendant accompany them on such trips.

Regional Statistics

Disability statistics are available from the Special Needs Survey for five regions of Canada:

1. British Columbia
2. Prairies (Alberta, Saskatchewan, Manitoba)
3. Ontario
4. Quebec
5. Maritimes (New Brunswick, Prince Edward Island, Nova Scotia, Newfoundland)

Regional incidences of transportation disabilities appear in Table 5. These range from a low of 2.3 percent in Quebec to a high of 3.5 percent in British Columbia, indicating the existence of regional differences.

TABLE 5

Regional Statistics

Region	*Total Population* (' 000)	*Disabled Population* (' 000)	*Disabled Percentage*
British Columbia	2136	75	3.5
Prairies	3196	84	2.6
Ontario	6823	205	3.0
Quebec	4977	114	2.3
Maritimes	1715	55	3.2
Canada	**18848**	**533**	**2.8**

TABLE 6

Percentage Transportation Disabled

Region	*Urban*	*Rural*
British Columbia	3.64	3.13*
Prairies	2.57	2.80
Ontario	3.03	2.90*
Quebec	2.44	1.93*
Maritimes	3.38	3.05
Canada	**2.90**	**2.67**

There also seem to be differences in the incidences of transportation disabilities between urban and rural areas, as shown in Table 6.

While differences are not significant at regional levels, they are on a Canada wide basis.

In addition, it is apparent that age is very closely related to the incidence of disability, as can be seen from Figure 3. In fact, the strength of the age relationship suggested

FIGURE 3

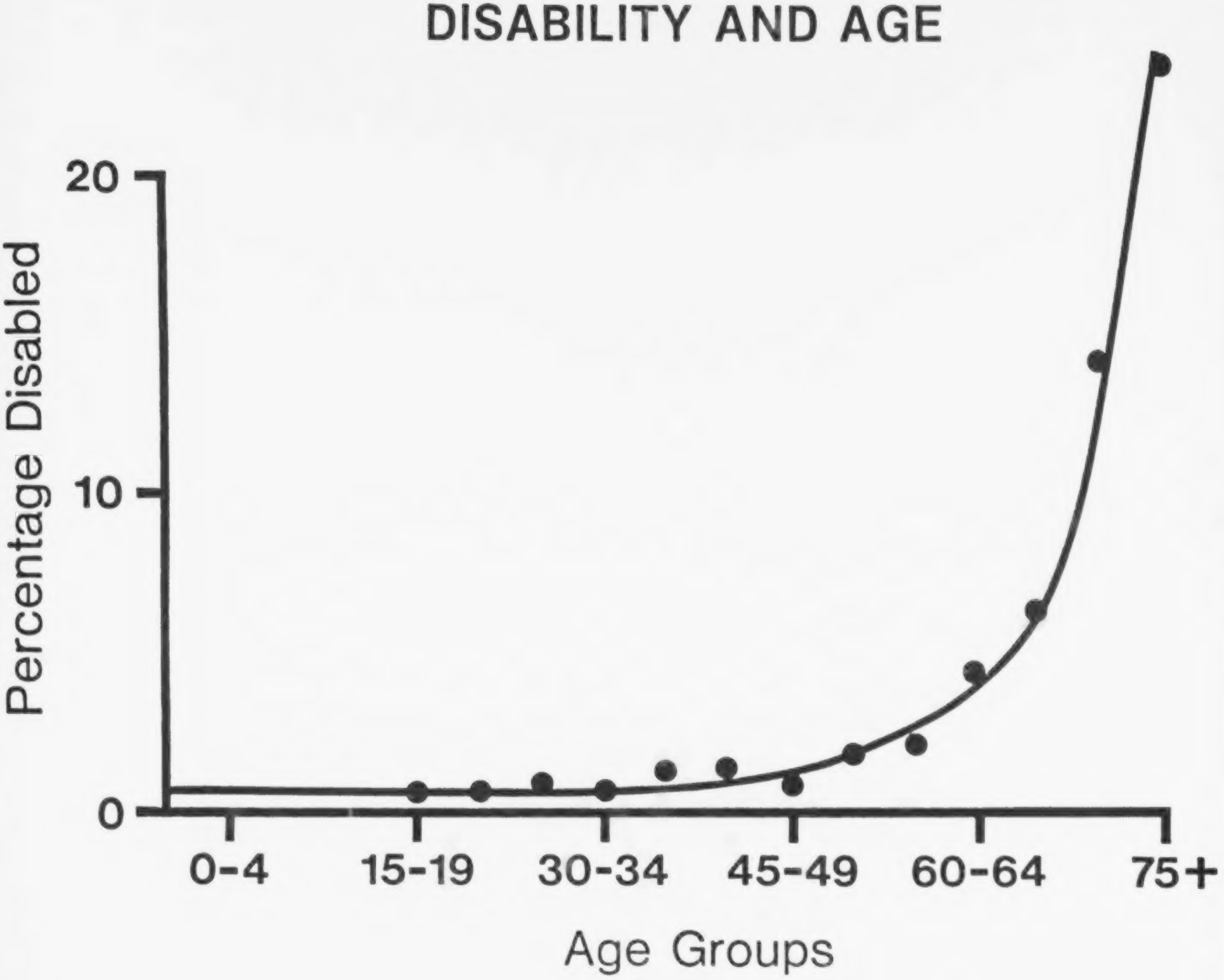

DISABILITY AND AGE
Percentage Disabled
20
10
0
0-4
15-19
30-34
45-49
60-64
75+
Age Groups

TABLE 7

A Comparison of Transportation Handicapped Statistics from Various Studies

Study	*Nature of Study*	*Survey Date*	*Target Population*	*Transportation Disabled as a Perecnt of Target Population*
Data Base	Based on U.S. UMTA Data 16,000 households	1976/7	Urban Centres People 5 years of age and greater	4.97
Ontario	Survey of Ontario, 15,000 households	1980	Province of Ontario All ages	2.1-3.9
Canada Health	Nationwide 12,000 12,000 households	1978/9	Whole population excluding territories, reserves All Ages	2.1-9.4
Canada Mortgage Data Handbook	N/A	N/A	Whole population of Canada	2.9-6.9
Special Needs in Public Transportation	Nationwide 13,000 households	1983	Whole of Canada excluding territories, and reserves. People 15 years of age and older.	2.8

that it may in fact be the explanation for the regional and urban/rural differences that were observed.

This hypothesis was partially borne out in a preliminary analysis of the survey results. Some approximate tests of significance were performed which showed an extremely strong age effect, and inconclusive findings regarding rural/uban and regional differences.

Comparison with other Data Sources

There are problems in comparing results from the Special Needs in Public Transportation Survey (SNPT) with other sources, due to differing survey methodologies, scopes, questions, and difinitions. However, an attempt is made in Table 7.

The Data Base Study (1979) produced an estimate of 4.97 percent as the percentage of the Canadian population who are transportation handicapped, where the definition of a transportation handicapped person is one who experiences general problems with vision, hearing, mobility etc., and who perceives that he/she has more difficulty using public transportaion than people without his/her problems. Note that this percentage includes those experiencing difficulties with all forms of urban transit (city buses, trams, subways), so one could expect this estimate to be higher than the SNPT results. In addition, there are reasons to believe the Canadian incidence of transportation disabilities may be lower than the U.S. incidence due to such things as a different health care system and the U.S. involvement in Viet Nam, which could not be quantified in the Data Base Study (1979) but which may cause results in this study to be overestimated for Canada.

In the Ontario Study (1981), a person was considered handicapped if he/she had a medical or physical conditional that resulted in functional limitations (for example, seeing or hearing) or restrictions on activities (for example, climbing stairs or doing housework).

Another group were classed as impaired if they had an impairment which was not functionally or activity limiting. In all, 5.4 percent of the population were estimated to be handicapped and 4.5 percent were estimated to be impaired. Unfortunately the activities used to determine if a person was classed as handicapped or merely impaired do not cover many transportation related activities, so that some people who experience transportation problems would have been classed as impaired. However, 39.7 percent of the handicapped population indicated that they were either unable to use or had difficulty using public transit. Thus at a minimum, one would estimate that 2.1 percent of the general population were transportation disabled. As a worst case, assuming that 39.7 percent of the impaired also had difficulty with public transit, gives an upper estimate of 3.9 percent of the general population being transportation disabled. Public transportation in this survey basically implied urban transit, which again makes direct comparisons difficult. It is interesting to note however that the most commonly reported difficulty, among those who have difficulty, was in getting on and off vehicles. Also of interest is that 46.4 percent of the handicapped reported some level of difficulty in accessing bus and train stations, and 41.3 percent reported difficulties accessing airports.

In the Canada Health Survey, it was estimated that 9.4 percent of the population experienced limitation in their major activity of housework, employment or education. Included in this figure were 2.1 percent who were inactive due to health, or could not pursue their major activity. These bounds are too broad to be of much use in estimating the incidence of transportation disabilities.

A fourth source, the Canada Mortgage and Housing Corporation Study, (1982) basically uses results from the Canada Health Survey, augmented with results from other studies. It estimated that 6.9 percent of the total population experience some form of difficulty in using transportation services. This figure is based on the 11.4 percent of the population estimated in the Canada Health Survey to have an activity limitation, including both major and minor activities, and results from the Data Base Study. The actual derivation of this figure is unclear. In addition, this study estimates that 33.8 percent of those with major activity limitations, estimated at 9.4 percent in the Health Survey experience difficulty with mobility. Assuming this group would then be transportation disabled, one then obtains a lower bound of 2.9 percent of the population that is transportation disabled.

Conclusion

The major results of the Special Needs in Public Transportation Survey are:

1. Mobility disabilities are the most common transportation disability, followed by seeing disabilities, then hearing disabilities.

2. While a large portion of transportation disabled individuals feel they cannot use public forms of transportation because of their disabilities, and an even larger group can and do use the various modes of public transportation.

3. Stairs/escalators, moving about a terminal, and boarding are the three most common difficulties encountered by transportation disable individuals. As was to be expected, those with seeing disabilities also have difficulty seeing signs, notices, and announcements, and those with hearing disabilities have difficulty hearing announcements.

4. The most common form of assistance is to have staff provide special assistance or to travel with a personal attendent. Those with mobility disabilities often use a walking aid or wheelchair, their own or carrier provided.

5. Transportation disabled persons live everywhere. There are no dramatic differences in the incidences of transportation disabilities between regions or urban and rural areas of the country. What differences there are seem to be mainly accounted for by the differences in the age profiles of the regions or areas.

6. The incidence of transportation disabilities increases with age.

References

Data Base Study for the Identification and Quantification of Transportation Handicapped Persons in Canada, (1979) Systems Approach Consultants Ltd. Prepared for Transport Canada.

The Sociodemographic and Need Related Chracteristics of the Physically Handicapped in Ontario (1981) (unpublished) J.W. Gilbert Associates Ltd. and Levy Coughlin Partnership Inc. Prepared for the Government of Ontario.

The Health of Canadian. Report of the Canada Health Survey, (1981) Health and Welfare Canada and Statistics Canada.

Data Handbook on Disabled Persons in Canada (1982) Medicus Canada. Prepared for Canada Mortgage and Housing Corporation.

Mara Lee McLaren and Marion S. Fleming, Research Branch, Canadian Transport Commission, Ottawa, Ontario, Canada KIA ON9

ADAPTATIONS TO STAGE CARRIAGE BUSES FOR DISABLED AND ELDERLY PERSONS

P. Oxley and M. Benwell

Introduction

In the mid-1970s research commissioned by the Transport and Road Research Laboratory (TRRL) showed that about four million people in the United Kingdom (UK) had difficulty in using, or were unable to use, typical buses then in service (Brooks et al). A recent household survey of elderly people (1982) showed that nine percent of people over 65 were unable to use buses solely because of physical difficulties and a further 16 percent did so only with great difficulty.

Even though the elderly and less able are an important subset of all bus users, they are a minority. From the operator's point of view, therefore, any modifications to bus design or operation have to be made in such a way that they do not work to the disadvantage of the able-bodied majority of passengers.

The Modifications Studied

South Yorkshire Passenger Transport Executive (SYPTE) has introduced two modifications to bus entrances, both intended to make boarding easier for the less able-bodied. These modifications, respectively the split step and "kneeling" bus, formed the starting point of the research. The split step configuration is shown in Figure 1 and is built so that in the rearward half of the entry the height from ground to the first step is reduced from approximately 37 cm to 28 cm (or about 17 cm from a normal height kerb). This half of the entrance then has two further steps each of 16.5 cm, while the conventional forward half of the entrance has only one step of just over 24 cm.

The kneeling mechanism was developed for single deck Leyland National buses with air suspension and, by exhaustinq the air from the nearside front bellows, allows that corner of the bus to drop by just over 11 cm to give a ground to first step height of 25.5 cm (see Figure 2).

Fieldwork had shown that a significantly higher proportion of elderly, handicapped and encumbered passengers used the lower part of the split step in comparison with the number using the equivalent rearward half of the straight unmodified step (Oxley and Benwell, 1983). The split step did not cause any significant changes to average boarding times. The kneeling mechanism had been found to be seldom activated by drivers so no firm conclusions about its value to users could be drawn. Both modifications were cheap to make and to maintain.

The Experimental Study

Objectives

The second stage of the study examined the two modifications in comparison with current standard buses under controlled conditions. This work also considered the effects on ambulant passengers of changes in driving regimes. The intention was to provide guidance on the design of buses and to estimate the passenger usage effects which might result from such changes in design and driving regimes.

Methodology

A representative sample of 55 elderly and ambulatory disabled people was drawn from a household survey in Bedford. The 55 people were categorised by type and severity of disability (severity of disability catgories were slight, moderate and severe) and were brought to Cranfield in small groups where they spent a day boarding, alighting and riding in four differnt buses. One bus (a single deck Leyland National) was fitted with the kneeling mechanism, one (a double deck Leyland Atlantean) had a split step entrance, and the other two (double deck Bristol and Olympian) were conventional double deck buses typical of vehicles in service in the UK. The passengers were timed boarding, alighting and moving within the buses and were questioned after each manoeuvre on each bus to ascertain their views on the ease or difficulty of each action. Measurements were also made of stride distance from a moveable pavement onto the bus step. Finally, each group of passengers was taken on a circuit on the Bristol and Olympian buses with the bus being driven in normal mode over one circuit and then in "careful" mode in which the bus remained stationary while passengers were moving to or from their seats.

Summary of Finding: Boarding and Alighting

The subjective comparison by the passengers of the ease or difficulty of boarding and alighting is summarised in Table 1. The passengers showed a clear preference for the two buses with the modified entrances so far as boarding was concerned, but in all cases alighting was found to be relatively more difficult.

When passengers were asked in detail for the reasons for their comments on ease of use, a number of further differences emerged between the four vehicles. Tables 2(a) and 2(b) summarise the comments made, divided into

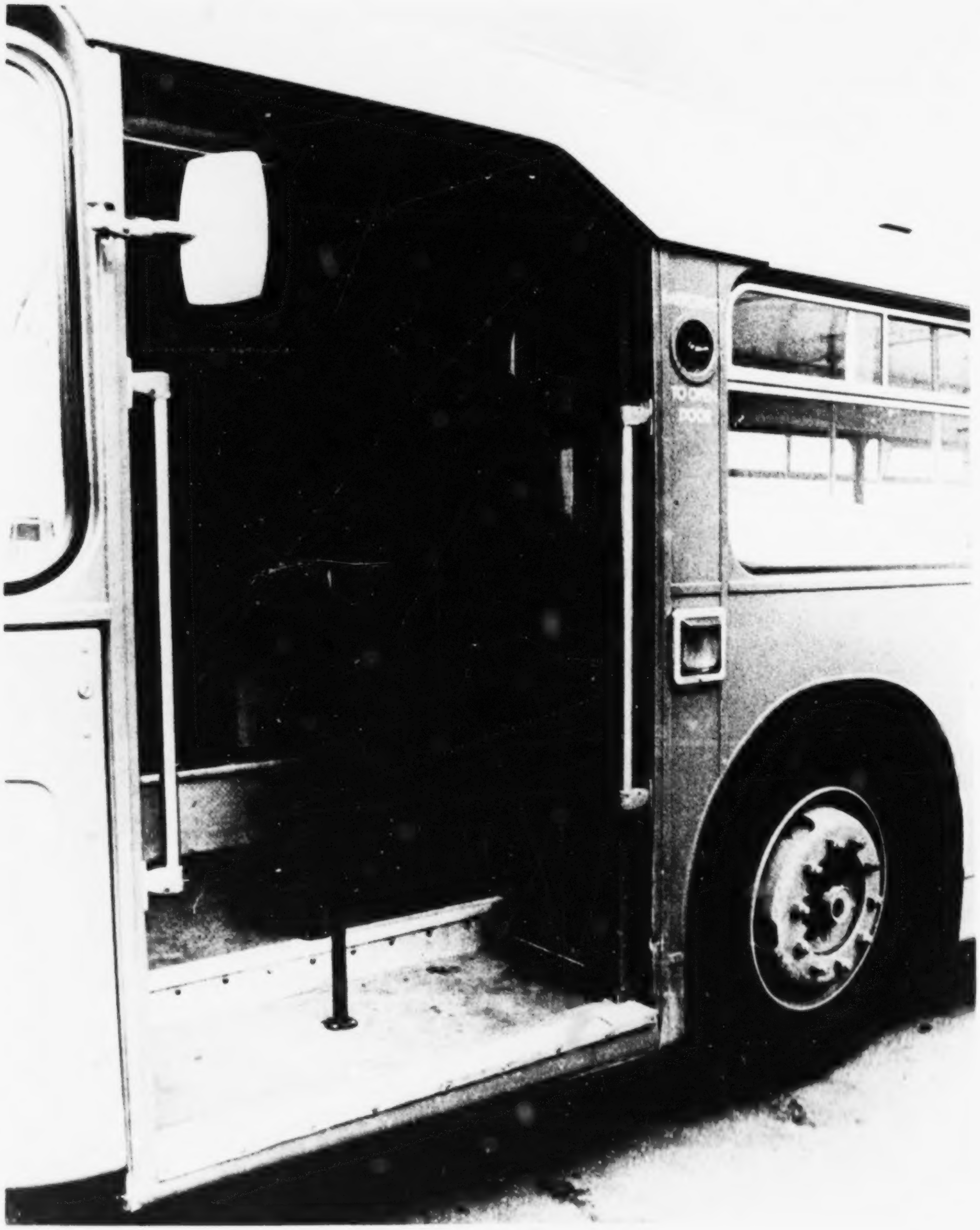


Figure 1: Front entrance of Bristol VR double deck bus

This type of vehicle is widely used for stage carriage operations. The height of the first step from ground level is 38 cm, the inner step is only 12 cm. Disabled passengers found the external vertical grab rails helpful but unfortunately these rails can present a safety hazard in operation.

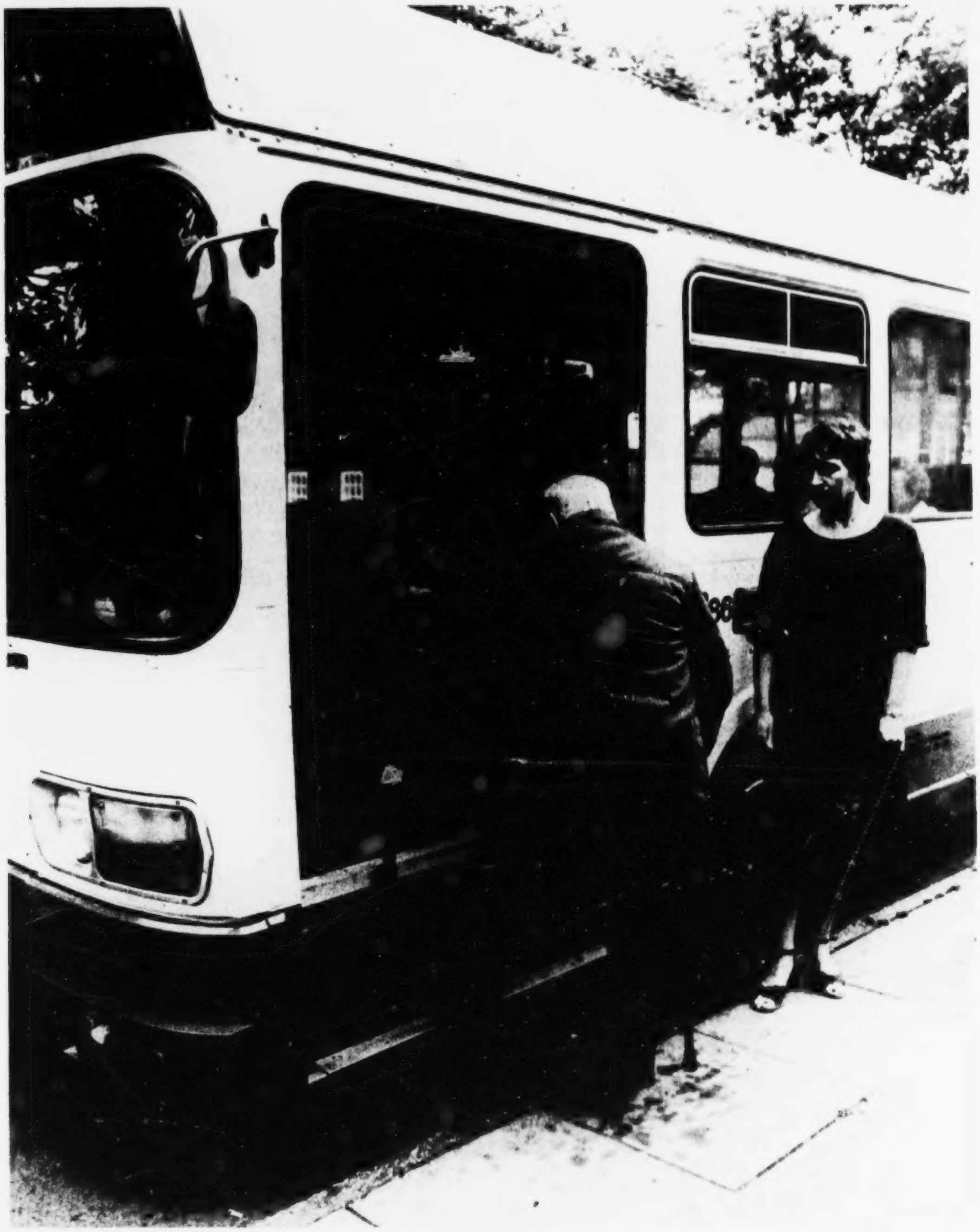


Figure 2: Front entrance of the Leyland National single deck bus

The bus is shown in knelt position, the height of the first step from the kerb just below is 20 cm; a distance that the disabled people were able to cope with without undue effort. The inner step is 26 cm high and was the cause of some criticism.

TABLE 1

General Rating of Ease/Difficulty with Each Bus Type

		Getting on			*Getting off*		
		Easy	*Neutral*	*Difficult*	*Easy*	*Neutral*	*Difficult*
Standard Buses *	Olympian	40 (73%)	9 (16%)	6 (11%)	28 (51%)	14 (25%)	13 (24%)
	Bristol VR	41 (75%)	6 (11%)	8 (15%)	33 (60%)	13 (23%)	9 (16%)
Modified Buses	Split step Atlantean	51 (92%)	1 (2%)	3 (6%)	34 (62%)	4 (7%)	27 (31%)
	Kneeling National (knelt)	50 (91%)	1 (2%)	4 (7%)	22 (40%)	5 (9%)	28 (51%)

* but with some retro-fitting of external stanchions and rails

TABLE 2a

Positive and Negative Comments on Steps and Rails by Bus Type
Getting on the Vehicle

	Comments on steps		*Comments on rails*		
	Favourable	*Adverse*	*Favourable*	*Adverse*	*No special comment made*
Olympian	5	9	16	3	22
Bristol	9	8	15	3	20
Split step Atlantean	16	7	11	11	10
Kneeling National (knelt)	15	13	9	3	15

TABLE 2b

Getting off the vehicle

Olympian	Front exit	3	15	12	1	24
Bristol VR	Front exit	2	17	5	4	27
Split Step Atlantean	Centre exit	2	9	9	12	23
Kneeling National (knelt)	Centre exit	0	29	8	5	13

those concerning the steps and those referring to hand rails. Getting on the buses produced favourable response to the steps on the two modified vehicles, but this was mitigated to some degree by a general preference for the position and dimensions of the handrails on the two standard vehicles. Alighting showed near unanimity of adverse comments on the steps, although the Olympian (the more recently designed of the two standard buses) again produced favourable response to its rails.

Movement with the Buses

A number of users commented on the need for rails at about 80 cm continuously or intermittently along the vehicle. The horizontal rail across the front of the bus (from the entrance up to the driver's compartment) was also found helpful. All users with stiff limbs shared a preference for those layouts where two seats were placed facing each other, forwards and backwards, to provide space for them to swivel their legs around when seated. Centre facing seats were avoided as were those on a raised plinth. The narrowing effect produced between the seats by the Atlantean's sloping seat backs was disliked as, indeed, was the sloping back itself.

The Atlantean has a slight gradient in the saloon floor from over the front axle back for the distance of 203 cm; the rise is only 5 cm but this drew adverse comments. So too did any obstructions (e.g. seat pedestals) which were close to the aisle. Passengers with sticks or special footwear were nervous about balancing themselves and also about having space around them to move their feet easily.

Gap Width Between Bus and Kerb

A frequent cause of complaint by passengers is that the bus does not draw up close enough to the pavement. A limited amount of testing was undertaken using a wooden platform to simulate a pavement and kerb 11 cm high. The platform was placed by the bus door at distances starting from 30 cm and increasing by 7.5 cm intervals up to 60 cm. Passengers boarded and alighted in normal fashion and the distance at which they first stepped down onto the road was recorded.

The results are shown in Table 3. All the passengers managed a stride of 30 cm and 88 percent managed 37.5 cm for both boarding and alighting. Thereafter the acts of boarding and alighting begin to diverge with, for a given distance, fewer people able to get off without stepping down onto the road.

The stride distance was considered in relation to the three impairment categories (see Table 3) which showed that over 90 percent of those with a slight impairment could manage a boarding stride of 45 cm compared with 78 percent of the moderate and 58 percent of the severe categories. The alighting pattern was more confused. Here the moderate catgory were less well able to manage the increasing distances than either the severe or slight categories.

Examination of the performance by health category showed that the arthritic group had the severest problems both in boarding and alighting, followed by those people with other leg and back problems. Those people with respiratory and heart conditions and with multiple problems were generally more able to stride longer distances both on and off the bus. Limited comparative testing using the lower step of the Atlantean entrance suggested that the reduced step height increases potential stride distance, particularly when alighting.

Boarding and Alighting Times

Individual passengers were timed boarding and alighting from the four bus types with the boarding manoeuvre being divided into two sections (from kerb to first step, from first step to past driver) and alighting treated as one manoeuvre from top of steps to both feet on kerb. Comparison of boarding times showed that overall the two standard buses produced the faster times. To some extent this was probably due to unfamiliarity with the modified buses since the earlier fieldwork had not shown any significant change in boarding times due to the split step configuration. If the times are analysed by reference to level of impairment quite noticeable differences do appear, as shown in Table 4.

Obviously, the figures conceal considerable variations, particularly among the more acutely impaired people. Taking those people used in the above table, their boarding times onto the Olympian were:

Severe, from 4 to 14 seconds

Moderate, from 3 to 7 seconds

Slight, from 2 to 4 seconds

Alighting times showed a similar range by impairment category with the two centre exit buses on average producing the longer times.

TABLE 3

Stride Distance by Impairment Category:
Percentage of Passengers Able to Stride Given Distance
(distance in centimetres)

	Boarding			*Alighting*		
	30 or less	*37.-45*	*Over 45*	*30 or less*	*37.5–45*	*Over 45*
Severe	25	25	50	17	33	50
Moderate	11	56	33	22	67	11
Slight	—	38	62	—	61	39

TABLE 4

Average Individual Boarding Times by Impairment Level Boarding from Kerb to Past Driver

(average boarding times in seconds)

Bus type	*Severe (M4, F8)*	*Moderate (M4, F8)*	*Slight (M5, F11)*
Olympian			
Men	7.2	4.7	3.1
Women	9.7	5.3	3.4
Bristol VR			
Men	6.6	3.8	3.1
Women	9.3	5.0	3.5
Split Step Atlantean			
Men	8.4	4.7	3.2
Women	8.6	4.7	3.2
Knelt National			
Men	7.2	5.0	3.7
Women	9.5	5.4	3.3

TABLE 5

Average Time (Seconds) from Past Driver to a Seat or Wheelstart

Observed category	*Average Time (in seconds)*	*Mode (in seconds)*	*Action Measured*
Ambulatory) experiment Disabled)	*8.8*	*7.8*	*Past driver to seat*
OMO single deck	*4.5*	*3.6*	*Last passenger past driver to wheelstart*
OMO double deck	*2.9*	*1.2*	
Crew operation	*2.4*	*1.2*	

Simulated Journeys

Circuits were made in two modes as follows:

1. Passengers allowed to board and sit and alight while the bus was stationary and the driver instructed to "drive gently" around the circuit ("wait" circuits).

2. Passengers board and alight in the normal manner, that is, with the bus starting when the last passenger in the queue had passed the driver and passengers rising from their seats before the bus stopped. On the circuit the driver was instructed to "drive normally" ("normal" circuits).

The average increase in wheel stop time when the bus remained at the stop until the last passenger was seated over "normal" operation was 45 percent (range + 23 percent to + 78 percent). Stop times when passengers alighted showed a much smaller increase over "normal" operation, the average increase being approximately two percent (range = 12 percent to + 20 percent). Although limited in scale, the results from this part of the study suggested that the time penalty for allowing ambulatory disabled passengers to reach a seat before the bus moves off and not to have to get up before it stops might not be substantial. Further fieldwork was therefore carried out to relate the experimental findings to the actual bus operation.

The critical time from the operator's point of view is the time the passenger takes to get from the driver to a seat, since the bus will not normally move off until the driver has taken the last fare or looked at the passenger's pass. The times for start of bus from last passenger past driver are shown in Table 5, from which it can be seen that in normal operation this time is typically two to four seconds; for the ambulant disabled (in the experimental study) the time taken to get from past the driver to a seat was eight to nine seconds. On modal values the difference is larger, since the distribution of times for all types of operation tend to have a fairly lengthy tail. The overriding feature of the figures, however, is that they are all small.

The other part of the use of buses which causes problems for the ambulatory disabled is that of alighting; specifically, getting up and moving towards the exit before the bus has stopped. Alighting in comparison with boarding is a much less important part of total bus running time. If net alighting time is defined as those occasions when either no one is boarding or when people are boarding, but those who are alighting take longer, net alighting time only amounts to three or four percent of total running time.

Using the observed incidence of ambulatory handicapped passengers in bus queues, together with the extra time needed to allow them to get to and from their seats while the bus was stationary, it was calculated that the net addition to total bus running time would only be of the order of one percent. To put this figure in context, recovery time is normally allowed for as about five percent of running time.

Conclusions

Operational Practice

The most important conclusion reached on operational matters is that relating to the effect of allowing disabled passengers to move to and from their seat while the bus remains stationary. It is concluded that to do this for boarding passengers would add only a little over one percent to the running time of the bus. The evidence for the effects of allowing disabled passengers to remain in their seats until the bus stops is less clear, but appears to be operationally insignificant.

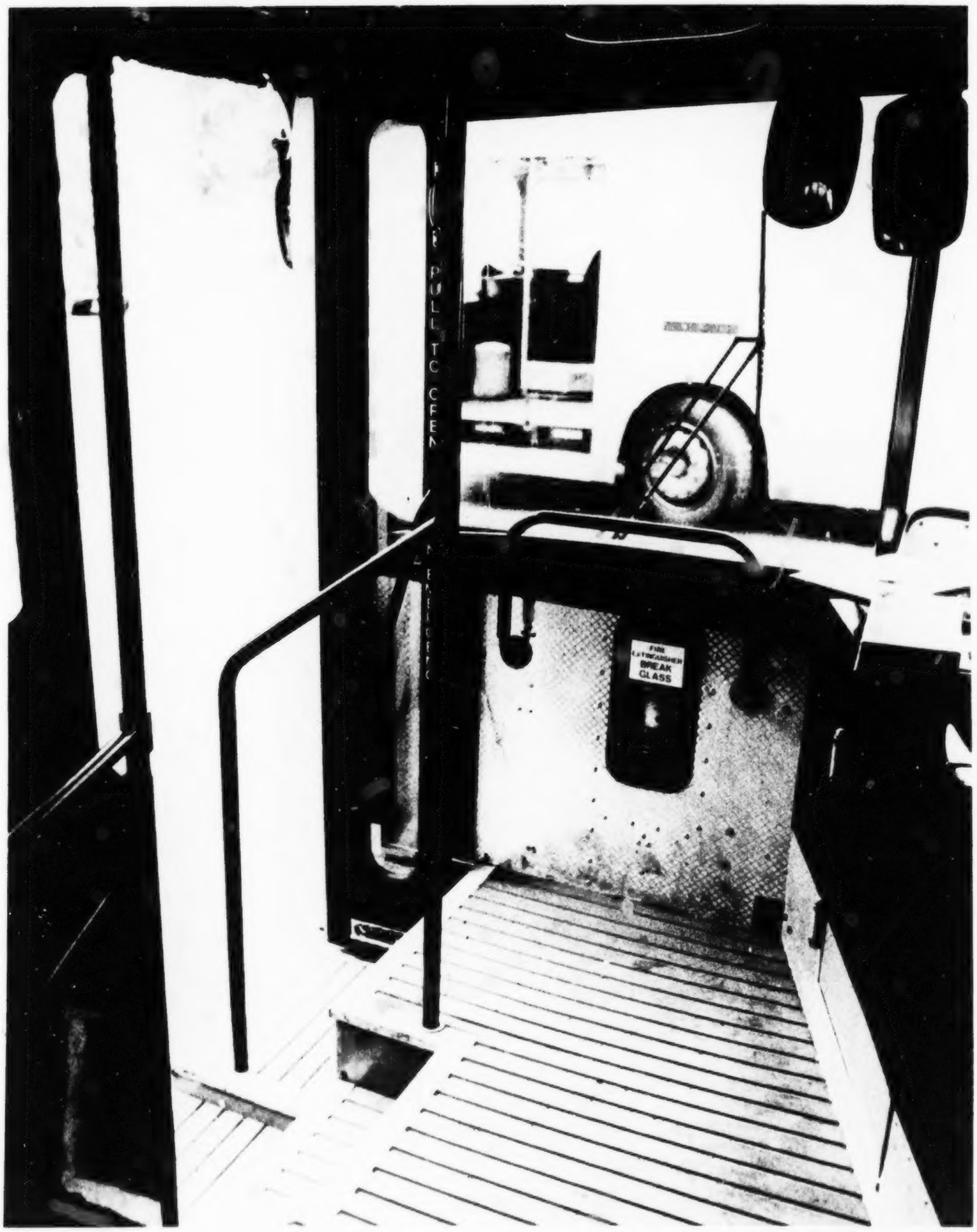


Figure 3: Front entrance of the split step Atlantean double deck bus

The rearward half of the entrance has a ground to first step height of 28 cm (or just below 20 cm from kerb height). The white nosing on the steps helps partially sighted people but the slight protrusion could cause difficulties for some disabled people. On its latest buses South Yorkshire PTE has specified flush fitting of the white strips.

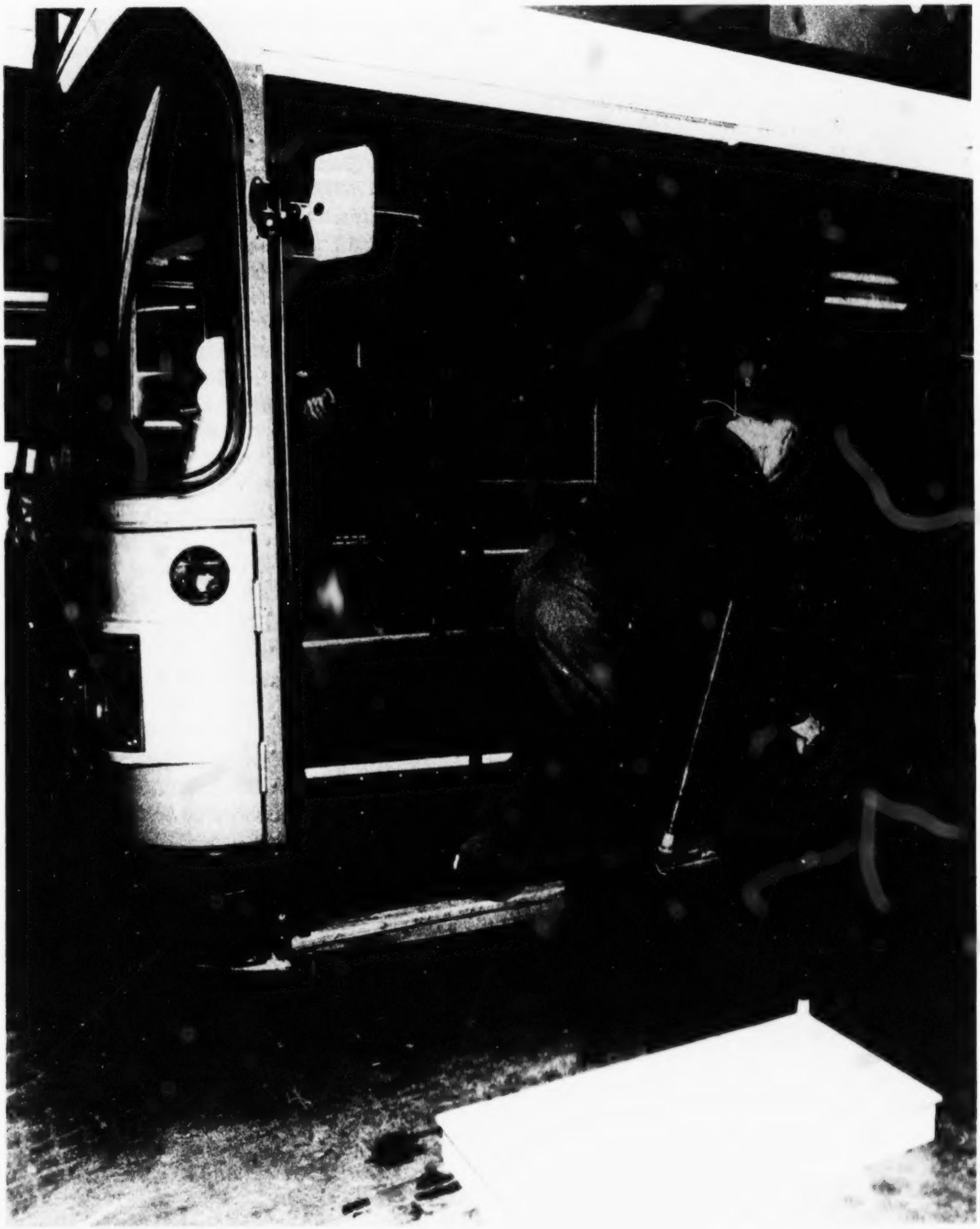


Figure 4: Front entrance of the Olympian double deck bus

This bus, which is widely used in current operations, incorporates design features found desirable by earlier studies made by British Leyland. It was used, as shown, to measure stride distance onto a mock pavement. The height of the first step is 30.5 cm (from ground) and of the second 22 cm.

Although passengers generally preferred the split step and the knelt National, neither the experimental work nor the fieldwork showed any significant difference in boarding times between these and the conventional buses. However, the experiment suggested that the modified steps help speed the entry of the most severely affected passengers.

All of the participants in the experiment were able to step directly between the bus and the kerb when the distance was 30 cm. The proximity of the bus to the kerb for boarding and alighting is probably more important in terms of the willingness of the disabled to use the bus rather than in the time taken to board and alight.

Design

For the ambulatory disabled there appears to be a break point in step height at approximately 20 cm. Above this figure criticisms of height were made; none was recorded at less than this. Fairly even height of steps is regarded favourably (e.g. as on the Olympian) as against the unequal proportions of the Bristol VR entrance. A shallow depth of tread causes problems for some disabled people; a width of 35 cm is suggested as an acceptable minimum. White nosing to the steps is an obvious help to the partially sighted, but this should be flush with the step. Even a very minor protrustion on the step riser can catch the toe of a disabled person as he pulls his foot up to reach the next tread.

Handrail and stanchion diameters should not be less than 3 cm. Oval shaped rails with 3 cm as a maximum diameter also appear to be acceptable. Handrails on doors, which move a little when any pressure is put on them, were disliked. The external fixed handrails on the Bristol VR were regarded as helpful, but for other operational and safety reasons, this type of rail is not considered satisfactory by bus operators.

Centre rails or stanchions should be as near as feasible to the front nose on the bottom step. The centre stanchion on the Leyland National, 32 cm from the nose to the bottom step, was considerd to be out of reach (or at least awkward to reach) for some people. The split step Atlantean (14 cm in) was liked (see Figure 3). There should be a horizontal handrail across the front of the bus from the step well to the driver's compartment, ideally at 80-90 cm above the saloon floor (see also Figure 4).

The allocation of the front pair of seats for disabled people makes operational sense since it reduces in-bus movement time. The placing of the front off- or near-side pair of seats facing backwards allows more room and comfort for people who find it difficult to bend their legs. The seats allocated for the disabled should have bell pushes accessible to people when they are sitting down.

Patronage Implications

Because the participants in the "experiment" were drawn from a random sample of households, and were asked questions comparable to those in a National survey of United Kingdom households, it is possible to make aggregate estimates on the basis of these small numbers. It was assumed, on the basis of study of their current trip-making and opinion survey responses, that the population of ambulatory handicapped could be divided into three groups on the basis of their likely response to the changes in bus design being tested. These were:

a. Those who would feel less discomfort but would not change their current use of buses: 0.7 percent total population.

b. Those currently using buses with difficulty and making fewer trips than they wish. These would increase their trip-making with design changes: 1.8 percent total population.

c. Those currently not using the bus, but who would with improved entrance / exit design (as in the experiment): 0.5 percent total population.

Thus categories b and c contain about 2.3 percent of the national population — some 1.2 m people. There is a significant commercial gain possible if these people could be persuaded to make just one or two trips more per person per week.

References

Brooks, B.M., Ruffell-Smith, H.P., and Ward, J.S. An investigation of factors effecting the use of buses by both elderly and ambulant disabled persons, British Leyland UK Ltd and TRRL, 1974.

General Household Survey 1982.

Oxley, P.R., and Benwell, M. The use of buses in Sheffield by elderly and handicapped people. Department of the Enviroment/Department of Transport. TRRL Report No SR 779, Crowthorne, 1983.

Philip Oxley, Principal Research Officer, and Mary Benwell, Center for Transport Studies, Cranfield Institute of Technology, Cranfield, England, MK43 OAL.

ACCESS TO STANDARD PRODUCTION CARS BY DISABLED AND ELDERLY PEOPLE

M.E. Page, J. Spicer, I.L. McClelland,
C.G.B. Mitchell, R.J. Feeney, and J. James

Introduction

In 1982 the Transport and Road Research Laboratory, on behalf of the Department of Transport, commissioned the Institute for Consumer Ergonomics in Loughborough University to investigate the problems experienced by disabled and elderly people when getting in and out of ordinary production cars.

The primary aims were:

1. To provide disabled and elderly people (both drivers and passengers) with the information necessary for choosing a car which would allow them convenient access.
2. To provide car manufacturers with data on the problems experienced by disabled people with regard to car access, with a view to overcoming them in future design.

The 16 month research program consisted of four consecutive phases comprising two surveys to obtain qualitative background information and two laboratory studies to obtain detailed quantitative information. The phases were as follows:

a. A local interview survey (57 subjects)
b. A national postal survey (588 subjects)
c. Trials with 6 production cars (64 subjects)
d. Trials with an adjustable car "buck" (60 subjects).

Survey Methodology

Local Interview Study

This small scale interview survey of 57 disabled and elderly car users was carried out in the county of Leicestershire. The aims of this survey were to gain basic information about the types of cars used by the sample, their reasons for choosing their particular cars, and the problems they experienced with regard to access. Each subject was asked to answer a series of questions and to demonstrate their methods of getting into and out of their own car so that the interviewer could record details.

Details of the Sample

Of the 57 people interviewed, 28 were drivers and 29 were passengers. Twenty-seven were men and 30 women. Wide ranges of age and disabilities were included and most people (84 percent) used a mobility aid.

Utilisation of the Results

This initial survey provided guidance for the subsequent stages of the research in particular the experimental protocol for user trials. On the basis of these detailed interviews, a written questionnaire was drawn up fro the next phase, i.e. a Postal Survey. The results and conclusions of both surveys will be discussed together.

National Postal Survey

In order to obtain a broader view of the problem, a national postal survey was carried. Whilst it is accepted that the sample could not be considered truly representative of the national population of disabled car users, it did give a much needed insight into some of their typical problems. Invitations to take part were inserted in suitable publications and 920 people expressed interest and were sent a 12 page questionnaire consisting of 5 sections:

1. General Information
2. Your disability
3. Your car
4. Using the car
5. Choosing another car.

Details of the Sample

Of the 588, 453 (77 percent) were drivers (294 of whom were also sometimes passengers) and 135 (23 percent) were passengers. 324 (55 percent) were men and 264 (45 percent) women; a very high proportion used a mobility aid and a third used more than one, the commonest combination being a wheelchair and one or two walking sticks; almost three quarters used a wheelchair.

Most respondents were regular car users, for example, 88 percent of the national sample used their car several times a week and almost half, 48 percent, used it more than once a day. The average annual mileage of the drivers is estimated to be rather more than 8,000 miles: this may be compared with the United Kingdom (UK) national average statistics for "all cars, vans and taxis" of 9,400 miles. The vast majority of the respondents necessarily took their mobility aid with them in the car.

Access to the Cars

The postal samples were classified according to their reported functional disabilities as shown in Table 1. Their techniques of entry and exit were then analysed and it was found that 4 percent needed to be lifted bodily in and out of their cars. A further 33 percent also needed

TABLE 1

Classification of Postal Survey Sample by Functional Disability

	Number	*Percent*
1. Limitation of upper limb only	12	2.1
2. Limitation of lower limb only	181	30.8
3. Limitation of both upper and lower limbs	196	33.3
4. Total loss of use of both lower limbs but unrestricted upper limb function	102	17.3
5. Total loss of use of both lower limbs and restricted upper limb function	77	13.1
6. No reported upper or lower limb restriction (includes those with back problems and those of very small stature)	20	3.4
Total	**588**	**100.0**

the help of an assistant, sometimes only to stow a wheelchair, whilst 49 percent could manage entry and exit with just their mobility aid to help. Fourteen percent required neither an assistant nor an aid.

The normal car entry technique used by the able-bodied involves twisting, ducking and transference of weight while balancing on one leg, grasping various parts of the car for support in the process. It was found in the interview survey that the majority of disabled and elderly people used other methods according to their various impairments and this was confirmed by the postal survey.

The most common method of entry for those who could stand but could not readily manage the technique used by the able-bodied was to sit sideways with both legs out of the car and then swivel round to bring the legs in, either both together or in succession; any sticks or crutches were brought in after the person was seated. Any instability due to one-legged support was thus obviated. Similarly on leaving, such people typically put out any stick or crutch first, then swivelled round and put their legs out to ensure stability before rising from the seat. Various parts of the car were used for support while rising, e.g. dashboard, facia, door, seat back.

People who had to make a sideways transfer from a wheelchair usually either swung into the car using their arms or slid sideways with or without the help of an assistant.

In addition to a person's handicap, certain car features affected the ease of entry and exit. The main features were the seat height and cant rail (lintel) height. Other secondary features were the angle to which the door opened, the presence or absence of suitable handholds and interior obstacles such as door pockets.

Stowage of Aids

Small aids such as sticks and crutches were rarely a problem but large bulky items such as wheelchairs or walking frames were frequently difficult, and 43 percent of the postal survey respondents needed help to stow their aid.

Description of the Cars

A wide variety of cars were found in both surveys. Approximately half of the cars were 4 door models and almost three quarters of the drivers had cars with automatic transmission.

In the postal survey, the six most commonly occurring types of cars accounting for 18.5 percent of the total were:

Ford Escort, Disabled Drivers Model—38 (5.03 percent)
Austin Mini 1000 HL—32 (4.24 percent)
Austin Metro 1.3—28 (3.71 percent)
Austin Mini Clubman—19 (2.52 percent)
Renault 5 Automatic—12 (1.59 percent)
Volvo 343—11 (1.46 percent)

Over half of the cars had been bought new within the previous four years and the major features considered by the owners when purchasing were stated to be:

Automatic transmission—42.1 percent
Wide/large door: easy access—40.8 percent
Economical to run—27.2 percent
Purchase price—25.6 percent
Comfortable/high seats—23.4 percent
Reliable/easy to maintain—23.2 percent.

In other words they were interested in general car performance features as well as those relating to easy access.

Most people sat in the car and tried to find out if the car would be suitable for them prior to purchase. However, under a third of drivers actually drove the car as they needed hand control which were not fitted until after purchase, when just over half of the drivers had hand controls fitted to their cars, chiefly brake/accelerator modifications. Other modifications included pedal modifications, steering wheel knobs, extended seat runners and alterations to the seat or cushions.

Utilisation of the Results

The postal survey confirmed that the local sample of disabled and elderly car users was sufficiently broadly based for it to be used in the laboratory trials. On the basis of the data obtained from the surveys, the methodloogy of the laboratory trials was established.

Trial Methodology

The Car Trials

Following the identification and classification of the problems experienced by disabled and elderly people when getting in and out of cars, the aims of the car trials were:

1. To identify and measure the principal dimensions of cars, associated with door apertures and seats, which have a critical influence on the ease of entry and exit.

2. To estimate, from analysis of the measurement of these cars, dimensions giving minimal problems, and establish a suitable range for each dimension to be incorporated in the subsequent experiments with an adjustable "buck."

3. To provide, in conjunction with the car "buck" trials, guidance for car manufacturers and car users regarding acceptable dimensions for the most critical features.

4. To provide manufacturers with information on the effect of detailed design features of the cars used in the trials.

To achieve these aims, six cars which reflected both the aperture sizes and current design practice were obtained and a group of disabled and elderly people were studied getting in and out. The six cars, all 1983 models, were:

Ford Escort Disabled drivers model, 2 door
Volvo 343 Automatic, 2 door
Austin Metro, 2 door
Honda Accord Automatic, 2 door
Vauxhall Cavalier, 4 door
Renault 5, 2 door

They were selected to give a wide variation of dimensions within the normal range of currently available popular cars. The intention was not to directly compare the cars themselves but to identify how features influenced ease of entry and exit. The subjects entered each car in a systematic fashion and detailed observations and written records were made of the sequence of moves, and the hand holds used and any problems encountered.

In addition, the subjects were asked to discuss the procedure, note any difficulties and rate the degree of difficulty of each part of the trial. For each car, the dimensions which might affect ease of entry and exit were measured to enable the dimensions of the car "buck" to be better estimated.

Details of the Sample

A total of 64 subjects took part; 34 men and 30 women. Thirty-one were drivers and 33 were passengers. There was a lower incidence of mobility aids, particularly wheelchairs, than amongst the two survey groups, due to the need for people fit enough for the fairly strenuous trials. To produce comparative data for able-bodied people, a few fit young people also completed the trials.

Utilisation of the Results

The data gathered in the car trials were of fundamental importance to the ultimate aim of providing advice for disabled and elderly car purchasers, and for car manufacturers wishing to meet these needs.

However, the immediate practical application of the data was to design the car "buck." Thus a number of critical dimensions were identified as follows:

- The height of the cant rail (lintel) from the sill
- The height of the sill from the ground and the depth of the footwell
- The height of the seat from the sill and the ground
- The longitudinal clearance between the seat and the front door pillar or "A" post.
- The "A" to "B" post distance

A comparison between the level of problems encountered with the associated aperture dimensions for the cars, enabled regression equations to be developed. These equations in turn enabled estimates to be made of the values for aperture dimensions which caused none of the subjects problems and conversely the dimension which caused 100 percent of the subjects problems. These dimensions were then used as a basis for selecting the range of adjustments in the "buck" trials. The effects of each of these critical dimensions on the ease of entry and exit will be discussed together with the complementary "buck" results.

The Buck Trials

Having established the car features which caused problems in the car trials and estimated a theoretical "ideal" set of dimensions which should cause minimal problems, it was necessary to test these features. This was done with an adjustable car "buck" which allowed the systematic alteration of one dimension at a time using a similar group of people to those in the car trials. The buck comprised a tubular frame with solid floor and roof, hinged doors, a dashboard, pedals and a steering wheel. Genuine car seats, which moved back and forth, up and down and sideways wer provided for the driver and passenger. The horizontal datum plane was the ground and the vertical datum plane was the front door pillar or "A" post. The range of adjustment for each dimension was arrived at from studying current car dimensions, the predictions from the car trials and pilot trials. The final choice is shown in Table 2.

TABLE 2

Summary of data used to select the range of adjustment examined in the car buck trials

Feature	*1981 Car Dimensions*	*User Trial Car Dimensions*	*Buck Range*	*Estimated "Ideal" from Car Trials*	*Selected Range*
Door Angle	—	—	0-180°	—	45-90°
Lateral position of seat	100-210	150-180	85-275	—	100-210
(Back of) seat height to ground	(Front of) 490-650	440-490	470^s	(Front of) 613	470-585
Sill height to ground	330-450	340-440	180-390	271	240-390
Footwell depth	60-200	100-195	0-195	59	50-100
Seat from edge to "A" post (rearmost position)	(Back seat to "A"post) 720-890	340-440	240-500	477	340-500
Cant rail height to ground	1219-1333	1235-1320	1240-1720	—	1260-1560
"A" to "B" post	740-1150	810-1065	770-1650	1208	770-1150

Units of measurement in millimetres unless otherwise specified

To minimise the effort involved in testing each dimension a rationale was developed to examine each feature in turn and thus establish a set of dimensions which each subject regarded as the limit of their acceptability. Having established these, a composite arrangement could be set up and the subject asked to check that this was, after all, acceptable overall. The order of testing was:

- door angle
- lateral seat position
- minimum seat height
- maximum sill height
- maximum foot well depth
- minimum seat from edge to "A" post
- minimum cant rail height
- minimum "A" to "B" post.

Details of the Sample

Sixty people took part. There were 38 men and 22 women, 35 drivers and 25 passengers.

Identification of Critical Features and Dimensions

Door Opening

Some doors on the trial cars were found to be heavy to pull (Volvo 343) and many were hard to reach without leaning very far out of the car. The buck trials found that an angle of 75 degrees was generally acceptable to all except those with special needs such as long unbending legs who might need 90 degrees.

Lateral Distance of the Seat from the Outer Sill Edge

Most subjects found 140mm acceptable, anything greater than this caused difficulty. Three of the six trial cars were within this limit.

Seat Height above Ground Level

In the car trials, the seat heights at the front ranged from 490mm to 650mm, and analysis predicted few problems at a height of about 613mm. This is approximately equivalent to a height of 510mm at the back of the seat. This was confirmed by the buck trials where 88 percent accepted 510mm. However, some people have special needs which can only really be met by an adjustable height seat.

Sill Height above Ground Level

Everyone in the buck trials found a sill height of 240mm acceptable, but above this height acceptability declined until only 20 percent found 390mm acceptable. None of the six cars in the trials had a sill below 340mm and three of them had sill heights of 390mm or greater.

TABLE 3

Dimensional limits for 90 percent or greater acceptance, as a result of the buck experiments, compared with the dimensions of the six cars used in the earlier trials.

Feature	*Dimensional limit for 90• or greater acceptance*	*Ford Escort*	*Volvo 343*	*Austin Metro*	*Honda Accord*	*Vauxhall Cavalier*	*Renault 5*
Door angle	75° optimum	—	—	—	—	—	—
Seat to outer sill edge	140mm max.	130	140	135	150	180	160
Seat height above ground	510mm opt.	450	545	460	440	450	540
Sill height above ground	240mm max.	340	410	390	350	365	440
Footwell depth	50mm max.	110	140	195	100	120	130
A-post to seat front edge	450mm min.	450*	440	345	390	358	340
Cant rail height above ground	370mm min.	1270	1320	1270	1235	1240	1290
A-post to B-post	980mm min.	1030	1065	990	1050	800	935

* Specially available on the Disabled Driver's model only

Footwell Depth (sill height above car floor)

Deep footwells such as were found in the Austin Metro (195mm) cause great problems when leaving the car. The ideal situation is to have a flat floor with no footwell but if it is necessary to have a footwell, it should not exceed 50mm.

Front of Seat to "A" Post

The longitudinal leg clearance between the seat front edge and the bottom corner of the "A" post is critical during entry and exit. Any obstacles such as door pockets situated in this region greatly exacerbate the problem.

Table 3 summarises the dimensions acceptable to most elderly and disabled people together with the corresponding dimensions on the six cars used in the user trials.

Supports Used during Entry to the Trial Cars

A variety of parts of the trial cars were used for support during entry and exit. In many cases the car parts used for support are likely to suffer abnormal wear and tear as a result of such usage. This is particularly true for the door where approximately half of the subjects leaned on the front of the top edge of the door thus putting a great strain on the door hinges.

Results from the Able-Bodied Subjects

Whilst the number of able-bodied subjects was very small, it is interesting to note that during the car trials, they were found to be troubled by the same features as the disabled and elderly people, although they could obviously cope more readily.

Utilisation of the Results

The results of the whole program are to be used to produce a report aimed at car manufacturers, advising them of the needs of disabled and elderly people. Already car manufacturers are showing interest in the results with a view to incorporating them in future car designs.

A further booklet aimed at disabled and elderly people themselves is also to be produced to help them select a car suited to their needs and disabilities.

Conclusions

The research program has shown that the disabled, elderly and the able-bodied all experience similar problems wth cars. Many of these problems are due to detailed design considerations rather than to structural engineering aspects. Thus, the clear design guidelines which have emerged are compatible with current car styling and will benefit all car users.

None of the recommended dimensions are beyond the range currently available on popular cars, although at present no single car incorporates them all but it is hoped that this will be remedied in the future. Meanwhile, much of the data on detailed design features can help the disabled traveler by suggesting the important access features to consider when buying a car.

Magdalen E. Page, J. Spicer, Ian McClelland, and Robert J. Feeney, Institute for Consumer Ergonomics, University of Technology, Loughborough, England LE11 3TU.

C.G.B. Mitchell and John James, Transport and Road Research Laboratory, Crowthorne, England, RG11 6AV.

MAKING CROSSING STRUCTURES ACCESSIBLE FOR ELDERLY AND HANDICAPPED PEDESTRIANS

Richard A. Richter and John C. Fegan

Introduction

Pedestrian overpass and underpass roadway crossing structures installed principally as safety improvements have been ignored by some pedestrians who seem to prefer the shorter, more dangerous, but slightly more convenient at-grade path across a roadway. A small group of the pedestrian population, the elderly and handicapped, however, typically prefer the safer but longer route across a structure. Nevertheless, this crossing structure still may not be a completely satisfactory crossing solution for elderly and handicapped pedestrians if their physical limitations are not compatible with some of the structure's design features.

Structure designers have for some time weighed the alternatives for making overpass and underpass crossing structures more serviceable to pedestrians. Of principal interest have been the approaches to the structure. Some handicapped pedestrians, such as those in wheelchairs, need a ramped surface to climb approximately 20 feet (6.1 m) to the walkway of most overpass structures. Other handicapped pedestrians, such as those on crutches, are better able to climb on stairs. Persons with restricted vision can be aided by guidance strips and tactile warning surfaces. Still other handicapped persons avoid relying on such special devices, stating that without uniform application, dependence on these devices is dangerous. Highway officials recognize the need to make pedestrian crossings as accessible as possible to all potential users and must deal with the problems of balancing cost with anticipated use, the conflicting demands of different handicapped users, and the trade offs between accessibility and user convenience.

Determining User Needs

A suitable pedestrian crossing structure should be accessible to a degree equal to or greater than the present or proposed accessibilty of connecting routes. This can be readily determined if the Priority Accessible Network (Templer et al, 1980) concept has been adopted. The Priority Accessible Network concept involves designating principal access routes for elderly and handicapped pedestrians, prioritizing the upgrading of those routes, and developing full accessibility for all major categories of handicapped pedestrians on each route at one time. As a major component of pedestrian routes, existing crossing structures often would be targeted for conversion to add accessible features or possibly added to the route system as a completely new link to an existng inaccessible network. One approach to determining the degree to which accessibility features should be added is to consider that elderly and handicapped pedestrians exist in a representative percentage within the overall pedestrian population. As the estimated pedestrian volume using a structure increases, so does the usage by the elderly and handicapped pedestrians. Many of the features such as rest areas, benches, lights, and special signs would then take on added importance as the overall pedestrian volume increases.

One of the most difficult aspects of designing a suitable pedestrian crossing structure is determining in advance the volume of use and nature of the users for the proposed crossing. Origin and destination surveys can estimate pedestrian desires to cross a physical barrier, but this potential will not be realized unless a sufficiently easy-to-use and convenient crossing facility capable of generating pedestrian use is provided. In trying to estimate use by the elderly and handicapped, the problem becomes even more difficult. Even if physical barriers are removed at a crossing, specific categories of handicapped persons may not use that particular crossing.

Two design philosophies are suggested. One is to survey the area surrounding a proposed pedestrian crossing to estimate the population of elderly and handicapped pedestrians. Then categorize those potential users into specific groups having similar needs for specific design features. The designer then is able to develop the required crossing facility features. Conflicting requirements of some categories of elderly and handicapped can be resolved when the categories within the survey area are determined.

The other design philosophy is to assume that the structure will be used by all of the major categories of elderly and handicapped pedestrians and to design the structure, approaches, and end connections with all of the desired features. This approach saves the time and expense of conducting a user survey but may unnecessarily add to the expense of the structure by including features that are not needed fully and would be used rarely.

A manual has been developed to aid structural designers in choosing what design features to provide and those to avoid, as well as appropriate specifications tc insure usable features for the handicapped pedestrian (Richter and King, 1983).

Two Principal User Categories

Two major groups of elderly and handicapped pedestrians are of principal concern in relation to crossing structures — those in wheelchairs and those who are blind. Wheelchair users need a ramp or mechanical lift to gain the elevation required to cross on a structure. Ramps appear to offer the best solution, but the optimum combination of grades and ramp length is sometimes hard to determine. Users range in their physical capability to travel on steep ramps. As ramp grades are made progressively less steep, they become longer—another undesirable characteristic. The basis for selecting ramp grades and the tolerance of users to long ramps have been investigated and are described later in this article.

The other user category, the blind, are not a homogeneous group when needs are considered. In addition to ranging from completely blind to the "legally blind" with limited sight, there are varying degrees of philosophies and techniques used by the blind for pedestrian movement. Some blind pedestrians prefer to perfect movement techniques allowing them to move without auxiliary aids. Others can facilitate travel by using supplemental aids for guidance, even though these aids are not provided everywhere. Typically, handrails are provided and serve to direct blind pedestrians across structures. A more recent development being considered for the blind pedestrian is the tactile strip or textured surface located for guidance along travel paths and for warning across paths. Blind pedestrians identify these strips by use of a long cane.

Until recently, not much was known about the kinds of surfaces that can be detected and identified using a cane or the criteria for determining a slip-proof surface on ramps and stairs. A method for specifying such surfaces when designing pedestrian overpass and underpass crossing structures was needed as well as a better understanding of the abilities of elderly and handicapped pedestrians to travel on sloping ramped walkways.

Research on Accessibility Feature

Ramp grades

Research was conducted to determine the length, gradient, and rest area configurations for long ramps (Templer, Wineman, and Zimring, 1983). Previous research had investigatd gradients of ramps up to 40 feet (12.2 m) long (Templer and Wineman, 1980). Pedestrian overpasses could, however, require ramps of up to 240 feet (73 m) long. Six ramp gradients from 1:10 to 1:16 were tested using 102 disabled subjects. On long ramps, the most important predictors of an individual's performance were his or her physical capabilities, age, sex, and other factors such as motivation, physical strength, and stamina. Physical characteristics of the ramp are much less important, but among these characteristics, gradient is the best predictor of performance.

TABLE 1

Ramp gradients for various climbing heights

Ramp gradient	*Maximum vertical height*	*Maximum linear distance exclusive of rest area*
	Feet	*Feet*
1:10.1 to 1:11.0	9	91.3/ 99.4
1:11.1 to 1:13.0	14	156.0/182.5
1:13.1 to 1:15.0	16	210.2/240.5
1:15.1 to 1:16.0	20	320.7/320.5

1 ft = 0.305 m

Analysis of the performance of manual wheelchair users indicates a relationship between users' abilities to climb ramps to a certain vertical height and the ramp gradient. The recommended gradients in Table 1 accommodate 80 percent of manual wheelchair users.

Landing Locations

For long ramps, 85 to 95 percent of test subjects were able to travel a considerable distance to their first rest stop. Subsequent rest stops need to be closer together. The location of the first rest stop is between 4.5 and 6.0 vertical feet (1.4 and 1.8 vertical m) depending on ramp gradient. Thus, the first rest stop should be located at 45 feet (13.7 m) for a 1: 10.0 ramp and at 95 feet (29 m) for a 1:15.9 ramp. Results of field tests indicate that ramp configuration (straight, dogleg) does not affect performance (Templer, Wineman, and Zimring, 1983). However, helical ramps are more difficult to negotiate and require a more gradual gradient for the user to perform as well as on a straight ramp.

Slip Resistance of Walkway Surface Materials

Twelve level walkway surfaces were tested for slip resistance (Table 2). Coefficients of friction greater than 0.3 are adequate for level pathways, but 0.4 and 0.5 are preferred. Thus, all of the tested materials meet this criterion. To convert these coefficients of friction to those for sloped surfaces, the following equation is used:

$$y = \frac{x}{\cos a} + \tan a$$

Where,

y = Static coefficient of friction on an inclined surface.

x = Static coefficient of friction on a horizontal (level) surface.

a = Angle on incline.

TABLE 2

Static coefficients of friction for various surface materials (level surfaces)

Surface Material	*Shoe material* Leather (dry)	Neolite (dry)[1]
Brushed concrete (New, against the brush)	0.75	0.90
Asphalt tile (Waxed, heavy use area)	0.56	0.47
Smooth metal (Rusted slightly)	0.54	0.49
Asphalt (Old parking lot)	0.53	0.64
Checker plate (Rusted moderately)	0.50	0.64
Quarry tile (Unglazed 6 in. × 6 in. tile)	0.49	0.60
Thermoplastic (Used on crosswalk)	0.45	0.86
Brick pavers (On stair, new no finish)	0.4[illegible]	0.73
Exposed aggregate (Pea gravel, heavy traffic)	0.41	0.57
Granite (Stairs, old, exterior)	0.40	0.66
Plywood "A" side (With grain, no finish)	0.39	0.75
Plywood "A" side (Against grain, no finish)	0.38	0.51

[1] Neolite was sanded smooth and flat.

1 in = 25.4 mm

The minimum coefficients of friction need to be greater for sloping ramps than for level surfaces. For a 1:10 ramp, for example, the minimum coefficient of friction required is 0.502 and the preferred value is 0.603. This corresponds to 0.40 and 0.50 for level walkways. Table 3 illustrates the minimum coefficients of friction acceptable for roofed areas and external surfaces. Fewer than one half of the surfaces when tested with leather soles meet the acceptable minimum, and only brushed concrete reaches the preferred level.

Surface Detectability

Twenty-two visually impaired people with little or no functional vision traversed orientation and warning test panels, and their abilities to detect each panel using a cane were recorded. Three qualities of surface materials were considered—surface texture, rebound, and impact sound. The tests indicated that the sound made as the cane traveled the walkway surface was the major factor in detectability. Texture of the panel was useful also.

Orientation Cues

Five tasks are particularly troublesome for visually impaired persons attempting to cross roadways: crossing open space, traversing nonperpendicular path intersections, finding the appropriate place to cross a street, finding an end connection from a broken or uneven path, and finding a dirt or gravel path end connection from a paved path.

Six countermeasures improved performance of the test subjects. These include the following in descending order of performance:

- A wooden shoreline—a 1 inch × 6 inch × 8 inch (25 mm × 152 mm × 203 mm) board staked to the ground paralleling the route.
- A sound-emitting device that produces a loud "chirp-chirp" noise to indicate an appropriate crossing location and time.
- A metal plate.
- A wooden plate—a 4 feet × 8 feet × 0.5 inch (1.2 m × 2.4 m × 12 mm) sheet of plywood.
- A rubber mat.
- A carpet mat. As with testing on surface detectability, landmarks that produce loud noise when struck with a cane are helpful as orientation, cues; distinctive rebound, as in the case of the rubber mats, is less helpful.

Needed Research

Relationships need to be developed between the volume of anticipated usage by representative categories of elderly and handicapped pedestrians and the design features intended to insure accessibility for the users within ech category. Design features need to be identified as to their importance for accessibility, that is, whether they are absolutely essential for accessibility or are optional features that merely would facilitate movement of the elderly and handicaped pedestrians.

User Manual

A manual has been developed to aid structural designers in choosing what design features to provide and those to avoid, as well as appropriate specifications to insure usable features for the handicapped pedestrian (Templer and Wineman, 1980).

References

J.A. Templer et al., "Development of Priority Accessible Networks," Report No. FHWA-IP-80-8, Federal Highway Administration, Washington, D.C., January 1980.

R.A. Richter, and C.L. King, "Guidelines for Making Crossing Structures Accessible to Elderly and Handicapped Pedestrians," Report No. FHWA-IP'84-6,

TABLE 3

Static coefficients of friction for level and inclined surfaces

Level	*Gradient –*					
Surface	*1:20 (5%)*	*1:18 (5.55%)*	*1:16 (6.25%)*	*1:14 (7.14%)*	*1:12 (8.33%)*	*1:10(10%)*
Minimum preferred for external surfaces:						
0.80	0.851	0.856	0.861	0.874	0.882	0.904
0.75	0.801	0.806	0.812	0.824	0.832	0.854
0.70	0.751	0.756	0.761	0.774	0.782	0.804
0.65	0.701	0.706	0.711	0.723	0.732	0.753
0.60	0.651	0.656	0.661	0.673	0.682	0.703
0.55	0.601	0.606	0.611	0.623	0.632	0.651
0.50	0.551	0.556	0.561	0.573	0.582	0.603
Minimum acceptable for external surfaces:						
0.45	0.500	0.505	0.511	0.521	0.531	0.552
0.40	0.450	0.455	0.461	0.472	0.481	0.502
Minimum acceptable for roofed areas:						
0.35	0.400	0.405	0.411	0.422	0.431	0.452
0.30	0.350	0.355	0.361	0.372	0.381	0.402

---

[1] The figure for the inclined surfaces is a calculated value. This value indicates that as the gradient of the walkway increased, a material with a higher coefficient of friction becomes necessary.

Federal Highway Administration, Washington, D.C., December 1983.

J.A. Templer, J.D. Wineman, and C.M. Zimring, "Guidelines for Accommodating the Handicapped on Crossings," Report No. FHWA/RD-82/124, Federal Highway Administration, Washington, D.C., December 1983.

J.A. Templer and J.D. Wineman, "The Feasibility of Accommodating Physically handicapped Individuals on Pedestrian Over and Undercrossing Structures," Report No. FHWA/RD-79/147, Federal Highway Administrtation, Washington, D.C., September 1980. PB No. 81 155004 available from the National Technical Information Service, 5285 Port Royal Rd., Springfield, Virginia 22161.

Richard A. Richter is a supervisory highway engineer in the Safety and Traffic Implementation Division, Office of Implementation, Federal Highway Administration, McLean, Virginia 22101.

John C. Fegan is a research psychologist in the Traffic Control and Operations Division, Office of Safety and Traffic Operations Research and Development, Federal Highway Administration, McLean, Virginia 22101.

CONCEPTUAL AND OPERATIONAL PROBLEMS IN SURVEYING THE DISABLED

M.J. Sheridan

Introduction

In February of 1981 a Canadian parliamentary task force known as the Special Committee on the Disabled and the Handicapped set forth in a report entitled Obstacles,[1] one hundred and thirty recommendations addressing various areas in which the federal government might improve its services to disabled persons in Canada. The Obstacles report pointed out the difficulties being encountered by agencies because of a lack of data on disabled persons. Consequently the task force recommended that Statistics Canada give a high priority to the development and implementation of a long term strategy which will generate comprehensive data on disabled persons in Canada.

In 1981 Statistics Canada began a process to establish a disability database which, when completed, will constitute an amalgamation of several data sources. One of the components of the disability database was a national household disability survey. This paper attempts to provide an overview of the conceptual and operational problems associated with the development of that national disability survey. It is hoped that the experience gleaned through Statistics Canada's work in this complex area of survey research will be helpful to those persons interested in pursuing the development of surveys to provide data on the needs of the disabled. The data available from this survey undertaking will provide the information necessary for the evaluation of programs and technologies intended to initiate new services or improve existing services for disabled persons.

This paper is presented in three parts. The first portion deals with the problems associated with selecting from a general survey individuals who are disabled, as well as a review of the methodology used by Statistics Canada to determine the appropriate selection criteria to identify the disabled in a general population survey. The second part presents some results of the testing conducted by Statistics Canada and a discussion of operational problems associated with the collection of data from disabled persons. The third and final part of the paper presents the final screening device established by Statistics Canada.

Selection of the Target Population

In survey research it is almost always true that the survey results one obtains are a function of the questions one asks. Nowhere is this adage truer than with the subject of disability. The importance of the wording of questions and their subsequent implications on the data set is probably best illustrated by the now well known story of the two priests, a Dominican and a Jesuit. The two priests were discussing whether it is a sin to smoke and pray at the same time. After much discussion, from which no conclusions were drawn, each of the priests agreed to consult their respective superiors. The next week they met again. The Dominican asked, "Well, what did your superior say?" The Jesuit replied, "He said it was alright." The Dominican was astounded and claimed that his superior had informed him that it was a sin. The Jesuit inquired, "What did you ask him?" The Dominican replied, "I asked him if it was alright to smoke while praying." "Oh," replied the Jesuit, "I asked my superior if it was alright to pray while smoking."

The illustration serves to underscore some of the concerns Statistics Canada had with the development of the appropriate line of questioning for their disability survey. The development of the initial questions which were intended to determine "who" was disabled hinged heavily upon the working definition of disability. As with the example of the two priests, the wording and administration of the questions which were intended to determine "who" is disabled were of paramount importance to the successful implementation of the survey. The definition of the population for which Statistics Canada was interested in collecting data is described as follows:

> All persons having one or more physical (non-behavioural) disabilities or knowledge acquisition or other educational disabilities (arising from impairments in intelligence, attention, psychomotor functions and language), whose duration has been or is expected to last at least six months. Also included are persons suffering from diseases of a chronic degenerative nature, and which have a high probability of producing impairments which are physically disabling.

The rationale for the definition employed by Statistics Canada was influenced to a high degree by the World Health Organization (WHO) definition of disability. The definition used for the survey is a spinoff of the WHO model used to focus on the consequences of disease. On a continuum the model looks somewhat as follows:

DISEASE ► IMPAIRMENT ► DISABILITY ► HANDICAP

A working example of this continuum might be described as follows. If one was interviewing a person with serious heart disease one might expect the following implications within the framework described above:

DISEASE ► Blockage of the valves in the heart

IMPAIRMENT ► Poor circulation, restriction of breathing, pain in the chest

DISABILITY ► Inability to perform normal daily activities

HANDICAP ► Limitation in the kind and amount of work or recreation

The task that faced Statistics Canada was to incorporate these definitions and concepts into a workable questionnaire which respondents would be capable of understanding and, at the same time, one which would yield the populations that fell into the scope of the definition of disabled. In order to assess the appropriate question sets, Statistics Canada conducted three different tests to determine the question options which might best identify the target population.

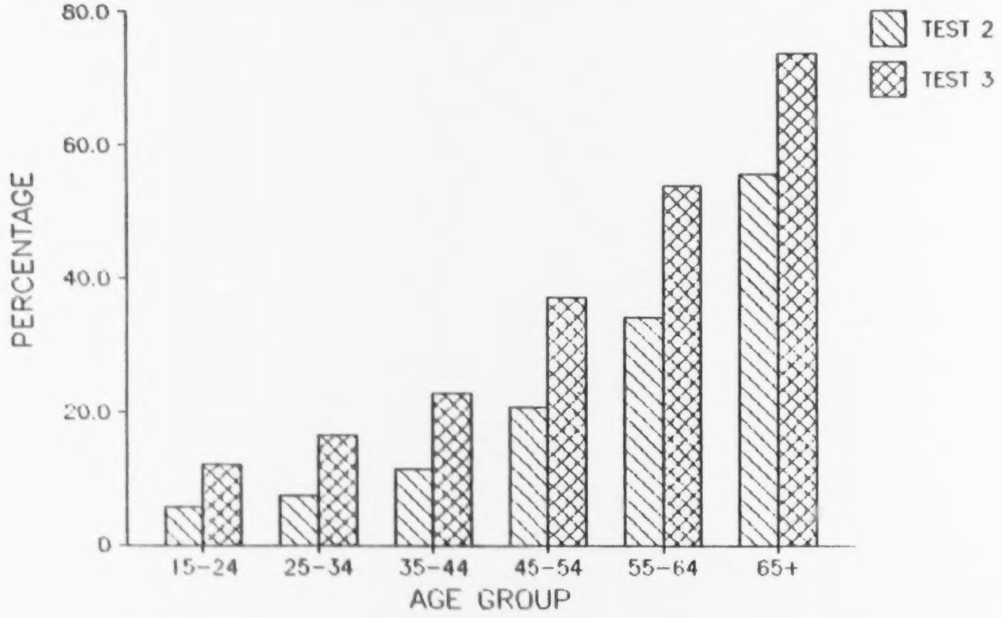
The main focus of the approach that Statistics Canada used to filter the population of interest, hereafter referred to as the "target population," was to develop a questionnaire which would act as a "screening mechanism." The screening mechanism was intended to identify those persons for whom a detailed follow up disability questionnaire was to be administered. The survey was thus a two stage operation. The first stage was to identify those individuals who fell into the target population. The second stage involved an in-depth interview concerning various social and economic issues with those persons in the target population. The purpose of the tests was to determine which of the several screening mechanisms developed was best suited to meet the field collection operations, and at the same time remain congruent with the definitions described previously.

The principal area of interest, and the primary approach finally used to screen the general population for the target population, was a derivation of one that has been used in other surveys. The focus of the tests was to assess a set of questions on Activities of Daily Living (ADL) which were combined with several other question sets that were considered as possible screening questions.

The Activities of Daily Living are a set of activities that any person is required to perform during the normal course of their regular living pattern. There is no generally recognized "best" set of activities that should be used. However, in 1978, the Organization for Economic Cooperation and Development (OECD) defined, through a working group composed of membership of several countries, a set of ADL's that could be used in most of the world's industrialized countries. It was a modified version of the ADL's developed by the OECD that Statistics Canada was most interested in testing, since at the outset these ADL's appeared to be most likely to yield a population which fell within the parameters of the working definition of disabled.

FIGURE 1

SAMPLE SCREENED IN BY AGE GROUPS



The general population survey vehicle on which the disability survey screen tests, and subsequently the detailed follow up interviews were conducted, was the Canadian Labour Force survey (LFS). Persons who wish a more detailed description of the Canadian Labour Force Survey are referred to the Statistics Canada publication, The Methodology of the Canadian Labour Force survey, Catalogue 71-526. For the purpose of the discussion here, we leave the description of the LFS as a stratified multistage probability sample of approximately 56,000 households across Canada. The data produced from the LFS are roughly analagous to the United States Bureau of the Census Current Population Survey. It should be mentioned that the LFS excludes persons living on Indian reserves, as well as persons who are institutionalized.

The Test Screening Questionnaires

The following section of the paper presents a description of the tests conducted to establish an appropriate screening mechanism. Test One looked at the possibility of defining the target population through the use of a single question approach. The idea behind the test of the single question was to assess how a self perception approach to the screen would work. At the onset it was expected that the defined population of interest might not be easily identified by a single question. The advantage of the single question approach was that it was the shortest and consequently had the lowest threshold of respondent burden. It suffered, however, from an inability to translate the definition of what constituted disabled to the respondents in the survey. The question that was used for test One was:

DOES . . . NOW HAVE ANY DISABILITY OR HANDICAP WHICH HAS LASTED OR IS EXPECTED TO LAST SIX MONTHS OR MORE?

The second test attempted to assess three types of screening questions. The question types can be divided into three broad categories.

These included:

1. The use of special aids (eg. wheel chairs, crutches, white canes, etc.)
2. Activities of Daily Living with the use of special aids.
3. Any other conditions or health problems which prevent or limit the respondent from carrying out his/her normal daily activities.

Test Three was also composed of three sets of questions. These sets of questions are broadly categorized as follows:

1. Activities of Daily Living without the use of any special aids or devices.
2. Limitation in the kind or amount of work.
3. Chronic conditions or health problems.

TABLE 1

Percent Screened in by Each Section of Each Test by Sex

	Percent Screened	
	Male	*Female*
Test 1:	5.5	5.7
Test 2: ADL with aids	14.7	16.2
Test 2: Aids	3.2	2.9
Test 2: Other	5.9	6.1
Test 3: ADL without aids	15.4	16.7
Test 3: Work Disability	13.0	13.1
Test 3: Chronic Conditions	23.2	24.6

The Results

The results of the three tests were very much dependent on the questions posed as well the respondent's perception of the question. Table 1 summarizes the results of the screen rates yielded by the various tests. It is interesting to note that screen rates vary substantially between Test One (the single question) and Tests Two and Three (the more complex question sets). Test One screened in about 5.6 percent of the population while Test Two and Test Three yielded a screened population of at least 15 percent, almost three times as many respondents as Test One. One of the hypotheses proposed for the very low screen rates for Test One was that the self perception question required the respondent to acknowledge a functional limitation in the form of a handicap or disability. In the other two tests the respondent is not required to acknowledge a disability or handicap. The manner in which the samples for the tests were set up permitted linkages between responses to Test One and those for Tests Two and Three. Analysis of the matched data from Test One with the data from Tests Two and Three indicated that the single question tends to only screen those persons who are more severely disabled. Using the one question approach as a screening mechanism is not recommended and was in fact dismissed as a viable screening tool by Statistics Canada. One further factor is worthy of note from Table One. It would seem that the differences in the screening rates between males and females are not significant regardless of the question sets used as a screen.

The comparative analysis of the data from Test Two and Three centered on the issue of special aids and their subsequent effect on the screen rates for the Activities of Daily Living. The concern was that the introduction of the use of special aids such as wheel chairs, crutches, walking devices, etc. would negate the utility of the ADL's as a screening device. The analysis of the data from Test Two (ADL's with the use of special aids) and Test Three (ADL's without the use of special aids) shows no significant differences between the screen rates. The

FIGURE 2

PERCENTAGE OF POPULATION SCREENED
TEST 2

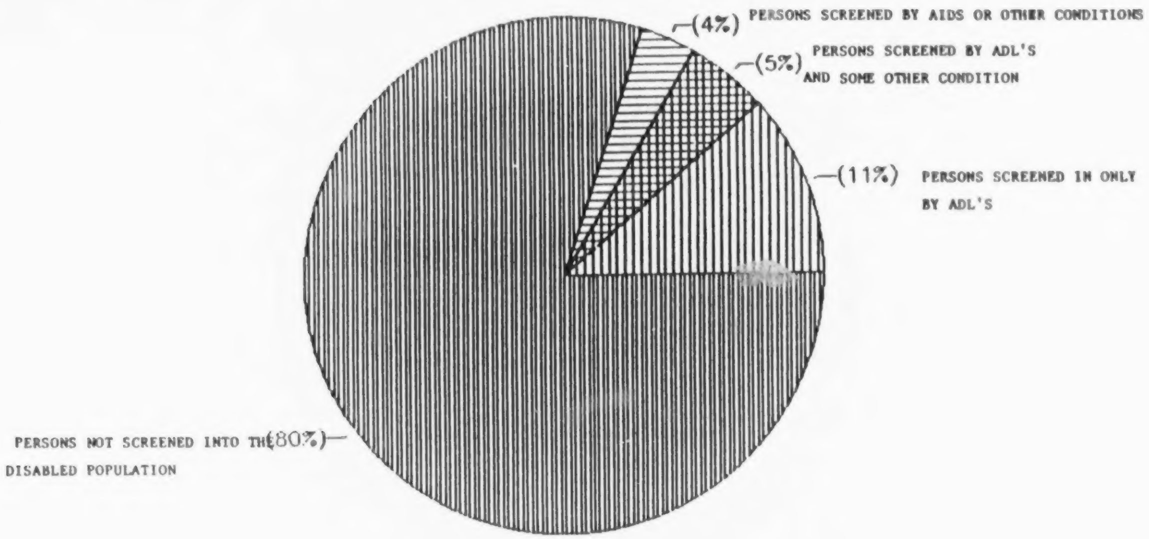


FIGURE 3

PERCENTAGE OF POPULATION SCREENED
TEST 3

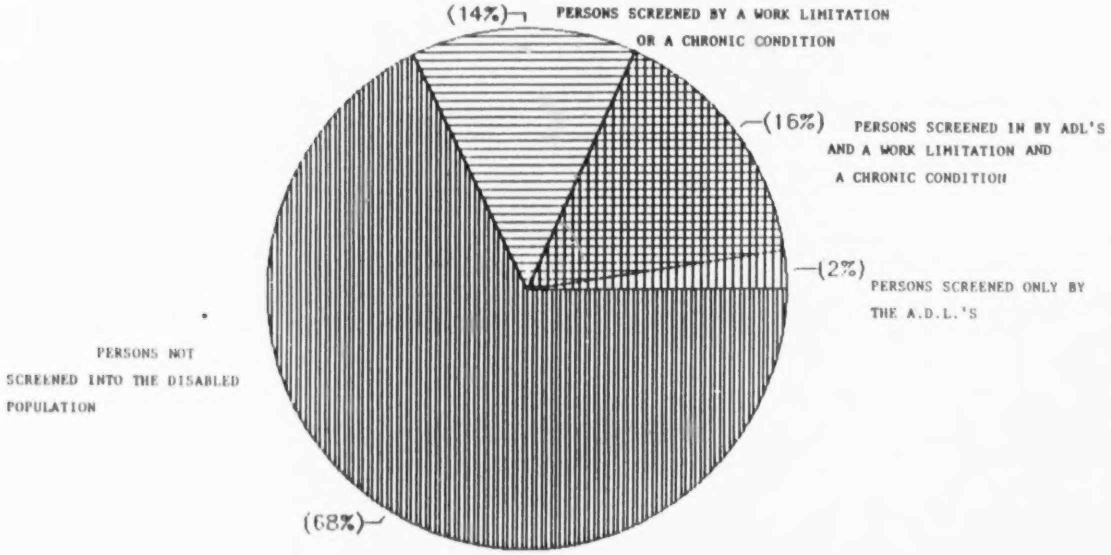
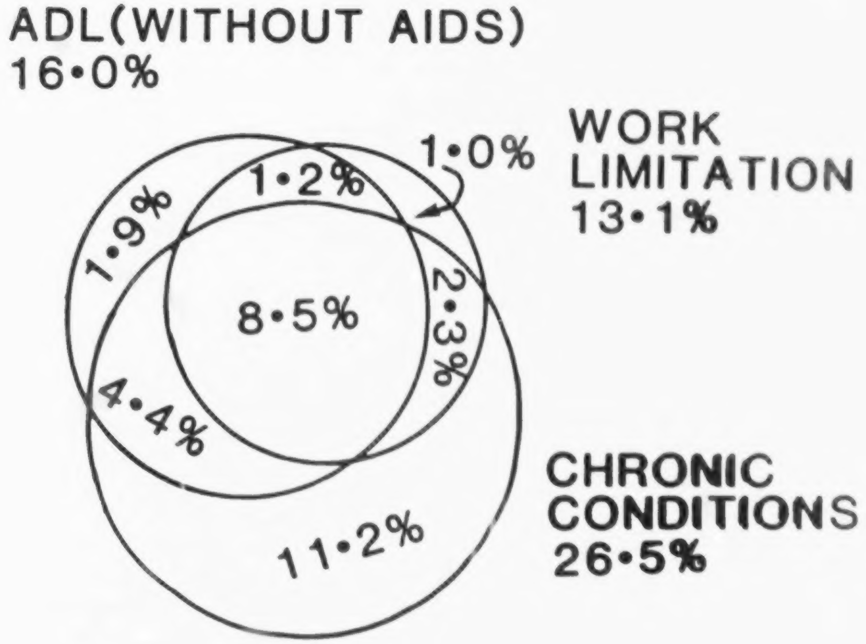


FIGURE 4 **TEST 3**



TOTAL SCREENED IN: 30•6%

TOTAL SAMPLE SIZE: 37,743

hypothesis presented as a result of the analysis was that although the use of a special aid may help a person with a functional limitation it does not completely eliminate all of the trouble the person may have performing the daily activities. Consequently, special aids have no significant impact on the screen rates one might expect from the list of ADL's constructed for the Statistics Canada disability survey.

One factor which does, however, have a significant effect on the screen rates is the age of the respondent. For both Test Two and Test Three the likelihood of being included in the disabled population increases with age. Not surprisingly, the likelihood increases more rapidly the older the population of interest becomes. Consequently, some questions were raised as to the applicability of the ADL's to more elderly populations and some consideration has been given to the development of a special set of ADL's for populations over the age of 65. The reason for the special consideration for elderly populations is that although the screening rates are higher for persons over 65, the degree of disability may not be as acute for these elderly persons as for younger respondents who are screened in by the same criteria. In fact a cursory analysis of the reasons for persons 65 years of age and older being screened in by the ADL's in many instances showed the reason as being "old age."

The list of chronic conditions used on Test Three yielded some interesting results in the context of a screening mechanism. It appears from the analysis of the chronic conditions data that many persons who claimed to have some chronic condition experienced no functional limitations as described by the ADL's. Further, many of these people experienced no work or other activity limitations. Analysis of the data from Test Three shows that at least ten percent of the persons included by reason of chronic condition or health problem had no trouble with the ADL's. For example, many persons identified high blood pressure as a condition which had no effect on their daily acitivities. A further problem which arose with the use of chronic conditions was the inability (or reluctance) of some respondents to classify their chronic condition on the list provided. As a result of the two problems described above, Statistics Canada decided to eliminate the use of chronic conditions as a viable screening mechanism to delineate the population of interest.

The ADL's by themselves and in combination with other question sets yielded the largest proportions of the population for both Tests Two and Three. It is also worth noting that in each of the tests the ADL's were roughly consistent in the percentages of the population that they screened. The major conclusions that were a result of the test process described above were that:

1. The definition of the population of interest is important to the successful implementation of any survey but is critical when dealing with collecting disability data.
2. The inclusion or exclusion of special aids does not affect the ADL's as a screening mechanism. Screened in rates appear to remain consistent with or without the use of special aids.
3. While the sex of the respondent does not seem to be a factor in the screen process, age is a factor in the use of ADL's as a screen mechanism. The older the population, the higher the screen in rate.
4. The use of ADL's, while appropriate for the population of interest for Statistics Canada's disability survey, may yield higher screened in rates for studies with more restricted population definitions.
5. A single question did not yield the appropriate population and was rejected as a screen device.

Operational Considerations

One of the major problems encountered in the tests with the use of ADL's as a screening device was that it provided no indication as to the degree of severity of the condition. For example, an individual who suffered from tennis elbow might be screened into the target population for the follow up survey. The lack of a severity indicator for the ADL's is, in and of itself, not a major problem with the screening procedures; however, its absence does create some problems at the time of the follow-up interview. The problems at the time of the follow-up are created because persons with minor conditions tend not to respond to the more detailed follow-up questions.

Children present a unique set of operational problems in the screening prooess. The ADL's can only be utilized as a screen for populations over the age of approximately ten years old. The daily activities described in the ADL's are for the most part not applicable to very young children. Statistics Canada was forced to develop a special screening mechanism to determine disability among young children.

It was determined that because of the length, complexity and possible sensitivity of the questions on the follow-up interview, a personal interview was the most appropriate collection method for persons screened into the target population. In addition, a review of other research in the area of collection of disability data showed that telephone interviews were not acceptable data collection methods. Telephone interviews were ruled out because of obvious problems for persons who are hearing impaired or who are deaf. In addition, studies of elderly populations have indicated that certain response problems were encountered when surveys were conducted over the telephone. These problems are further enumerated in Herzog et al (1983).[2]

Although it was Statistics Canada's experience that the ADL's screened a population close to the definition of disabled, they present the researcher with several operational concerns. The major problem with the use of the ADL's as a screening mechanism is the requirement that seventeen questions be posed to each respondent in the population in order to determine if the person belongs in the target population. This is a particular problem when posing the questions to very healthy respondents. Debriefing reports from interviewers after the administration of Tests Two and Three indicated some reluctance on the part of respondents to answer the full set of ADL's. Despite their effectiveness as a screen mechanism the drawback of the ADL's would seem to be the amount of burden placed on respondents. A further problem associated with the time required to administer the ADL's is the cost factor. The increased interview time means increased expenditure for collection costs.

As a result of the analysis of the data from the test, it was determned that the most effective screening mechanism was the ADL's question set. However, in the analysis of the ADL's sub sets of the population were screened in by criteria other than the ADL's. For example, roughly 12 percent of the population who claimed to have a chronic condition were not screened by the ADL questions. Further, one percent of persons who claimed to have work limitations were screened by neither the ADL nor the chronic condition questions. As mentioned earlier, analysis of the chronic condition data showed a large portion of those persons who were identified as having chronic condition fell outside the scope of the definition of disabled (eg. allergies or mild high blood pressure). Despite this fact, it was felt that there were some small subsets of these populations not screened by the ADL's who should have been a part of the target population. In order to account for these persons it was deemed appropriate to develop a single "catch-all" question to enhance the screening capabilities of the ADL question set. Thus the final screening mechanism developed by Statistics Canada was a set of eighteen Activities of Daily Living questions and a single "catch-all" question. The final ADL questions and the catch-all question that made up the final screening mechanisms are described below.

Does the respondent have any trouble . . .

1. walking 400 metres without resting
2. walking up and down a flight of stairs
3. carrying an object 5 kg. 10 metres (a 12 lb. bag of groceries 30 feet)
4. moving from one room to another
5. standing for long periods of time (more than 20 minutes)
6. when standing, bending down and picking up an object from the floor
7. dressing and undressing
8. getting in and out of bed
9. cutting own toenails
10. using fingers to grasp or handle
11. reaching
12. cutting own food
13. reading ordinary newsprint
14. seeing clearly the face of someone from 4 metres (across a room, with glasses if normally worn)
15. hearing what is said in a normal conversation with one other person
16. hearing what is said in a normal conversation with at least two other persons
17. speaking and being understood
18. Is the respondent limited in the kind of amount of activity he/she can do at home, at work or going to school because of a long-term physical condition or health problem?

References

1. *Obstacles.* Report of the Special Committee on the Disabled and Handicapped. Canada, House of Commons, Ottawa, Ontario, Canada. February 1981.

2. Herzog, Regula A., Rodgers, Willard L, and Kulka, Richard A, "Interviewing Older Adults: A Comparison of Telephone and Face to Face Modalities". *Public Opinion Quarterly,* Vol 47, 1983 pp. 405-418.

Acknowledgement

The author acknowledges the assistance of J-P Morin who helped prepare some of the data in this paper, and the use of material from internal Statistics Canada working documents prepared by D. Dolson and P. Giles. Opinions expressed are those of the author and may not necessarily be the views of Statistics Canada.

Michael J. Sheridan, Associate Director, Special Surveys Division, Statistics Canada, Ottawa, Ontario, Canada KIA OT6.

PUBLIC TRANSPORTATION FOR THE ELDERLY IN SWEDEN: TECHNICAL AND BEHAVIORAL ISSUES

Agneta Stahl

Background

Elderly people are limited in their choice of mode of transport. A study carried out in Sweden (Stahl, 1984a) found that less than 25 percent drove a car and about 35 percent lived in car-owning households. In Sweden, an average of 85 percent of the population reside in car-owning households. This study also indicated that, in terms of choosing a mode of transport, elderly fall into two extremes, almost equal in size: 1) persons with a car in the household and still driving and 2) persons with no personal transport, thereby dependent on public transport.

The two groups consist, for the most part, of quite different elderly people. In the group with access to a car and still driving, there is a higher representation of elderly under 75 yars of age and males. These persons are often healthy and not suffering from physical decline to the same extent as persons belonging to the non-driving group. There are further indications that it is the eldest, largely female, and persons with physical disabilities associated with the normal aging process who are most dependent on public transportation or on pedestrianism for their mobility. Accessibility to public transportation is limited for the latter group, to difficulities getting on and off a bus or to inconveniences while travelling on the bus. Nevertheless, a majority of the elderly of necessity use the bus for their daily transportation needs.

In discussing accessibility to public transport for the elderly and handicapped it is important to take into account all aspects of the journey. The problems experienced by elderly travelling in buses can be divided into four areas:

- problems related to the journey from home to the bus stop, such as the distance from one's residence; slippery pavements; high curbs; and unexpected steps.
- problems related to the bus-stop. These are often caused by a lack of shelters and/or benches or inadequare snow removal in the winter.
- problems related to exiting / entering the bus, such as the high first step on buses; the design and function of the handrails; the distance between the curb and the first step at bus stops.
- problems related to the bus journey, such as the difficulties when bus stops are not announced by the driver, and the bus departure from stops before persons are safely seated.

Making public transportation more accessible to the elderly must be viewed from the perspective of the forecasted demographic growth of the eldest in Sweden. The age-group 80 years and above is expected to increase in number as we approach the year 2000 while the youngest, those aged 65-79, will start to decrease in the 1990's. Among the eldest, one is likely to find most persons dependent upon public transportation. Therefore, it seems important to ascertain what efforts can be made to make public transportation more accessible to the group in a society highly dependent on public travel. Currently in Sweden, both research and applied studies on these problems are underway. This paper focuses on several projects which the Department of Traffic Planning at the Lund Institute of Technology has undertaken. But first a few words about Swedish policy on transportation for elderly and disabled persons.

Swedish Policy on Transportation for the Elderly and Disabled

Over the past ten to fifteen years the Swedish government has taken a special interest in elderly and disabled person's transportation problems and prospects.

To satisfy the transportation needs of groups experiencing difficulties travelling by public transport, a special transport system for the handicapped and elderly was established in the early 1970's. Today every municipality can offer their inhabitants a special transport system which requires applying and qualifying for a special permit. This permit is mainly meant for persons with quite serious disabilities who qualify for special services provided either by vans or subsidized taxis.

A governmental grant for the cost for this service is given to the municipalities. The rules vary considerably between municipalities concerning the way persons qualify for this service and the fare to be paid by the person travelling. The most common rate of payment for the user of the special transport system is 20 percent of the costs of the journey when using subsidized taxicabs. A person with a special permit can use the special transport service for almost any purpose.

By 1984, annual costs of this special transport system have increased considerably. About 300,000 persons, almost 4 percent of Sweden's population, currently have a permit for use of the special transport system and about

85 percent of those are 65 years of age or older. This means that approximately 18 percent of the population in this older age-group are travelling on the special transport service. About 95 percent of the journeys are made by taxicabs. The cost for this service in the early the 1980's was over 700 million Swedish crowns and the estimated increase per year is about 10 percent (Stahl, 1983a).

The intent of Swedish policy for disabled persons is to integrate the disabled into the society to as large an extent as possible. The increasing cost of the special transport service, has forced Sweden to improve public transport to encourage its use by elderly and handicapped persons.

As part of Swedish transport policy, the Swedish Board of Transport was established in 1979 and has, among other things, been given the responsibility for planning, initiating and following up the adaptation of public transport vehicles and facilities to a higher level of accessibility.

In early 1982 the Swedish Board of Transport issued their first regulations on buses and other public transport vehicles effective the 1st of January 1984. (Swedish Board of Transport, 1983) The policy states that buses in urban areas are not required to be adapted to accomodate wheelchairs, whereas buses intended for non-urban areas are.

The Department of Traffic Planning in Lund has been involved in evaluating the impact of these regulations, including how far the adaptation has proceeded and its benefits to the elderly. A review of these regulations and their effects, together with results from one study field follows.

Regulations by the Swedish Board of Transport

The Regulations

The proclamation by the Swedish Board of Transport includes regulations for modification of all public transports facilities to benefit the elderly. On buses it dictates, among other things, that

- the height of the first bus step, above the road, shall not exceed 200 mm;
- the width of the front door has to be at least 700 mm;
- the design and function of the handrails which may be round or oval in form;
- the interior of the bus, including for example, number and placement of seats reserved for disabled and elderly rides;
- announcement of bus-stops and other information by drivers;
- the height of figures and letters on destination signs (e.g., the height of the figures at the front of the bus must be at least 200 mm).

Despite the fact that these regulations have been in effect for several years, and many of the regulations do not require substantial efforts from the bus companies, the adaptation has proceeded very slowly. An investigation (mail survey) of the adaptation (Stahl, 1983b) showed that among the large bus companies in Sweden at least two thirds had started such adaptations. Of the companies which have started adapting, the extent of adaptation varies considerably. For example, the regulations on destination signs (the height of figures and letters) have proceeded furthest together with providing special seats for the disabled and elderly. More than 50 percent of all buses meet these requirements. However it is likely these requirements were interpreted differently, which may explain the high percentage. The Board's regulations say there should be some kind of destination sign on both the front, back and side of a bus. It is believed some respondents answered affirmatively on that point when in fact their buses have destination signs on the front only. Another desired adaptation is to make the first step no higher than 200 mm. This has barely been initiated, though different technical solutions are still being reviewed.

To sum up, according to our study

- every 4th bus has round or oval handrails.
- every 8th bus has handrails marked in contrasting colour
- every 3rd bus has the required correct destination signs
- every 40th bus has a low first step
- 2 buses out of 3 have seats designated for elderly and disabled persons.

Company officials estimated that at most 20 percent of forthcoming bus stops are announced, by drivers when specifically asked to do so by a passenger.

Study of Bus Regulations

1. *Study of Effect of Bus Regulations*

In order to find out what extent some of the proclaimed regulations improve the exiting/entering situation for the elderly, a field experiment was conducted. For the experiment one ordinary bus and one adapted bus were used. Two things were investigated—the importance of a lower step and special designed handrails (Stahl, 1984a)

Methodology

The adapted bus used for the experiment consisted of an extra low step activited at the bus stop and controlled by the bus-driver (see Figure 1). The height of the first step on an ordinary bus is usually around 350 mm. The inclusion of the extra step not only lowers this first step to 200 mm, but it also means that all the steps can have a height of 200 mm. Having equidistant steps is considered to be the best design for the disabled.

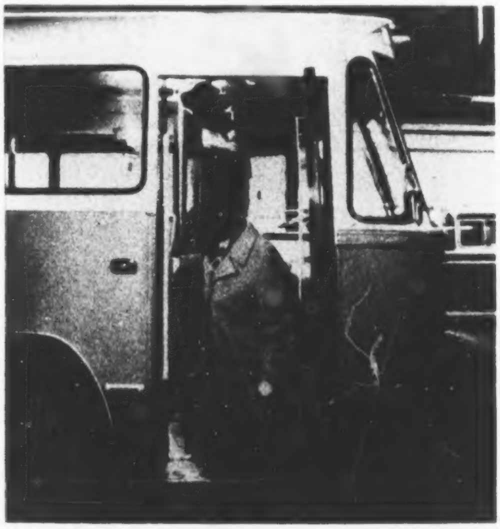


Figure 1

Seventeen persons with eyesight problems or ambulation participated in the experiment. In an earlier study they admitted to problems when entering/exiting buses. Each person was asked to enter and disembark both types of buses, first at an indoor site and then at a regular bus stop. Several photos were taken for each boarding and analysed later. In addition, a subjective amount of information was obtained through a brief interview with each subject after the entering/exiting process.

2. *Findings of the Study*

The first bus step above the road is often the one that is most troublesome to elderly on entering and exiting a bus. When entering the bus a person with some difficulty in ambulation must make a strenuous effort to mount the bus (see Figures 2 and 3), a problem related to the height of the step.

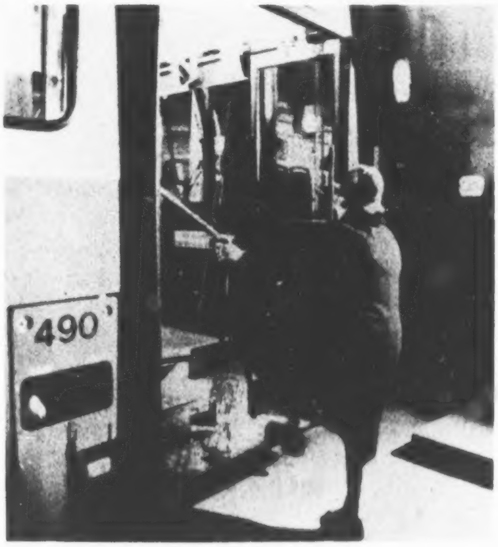


Figure 2

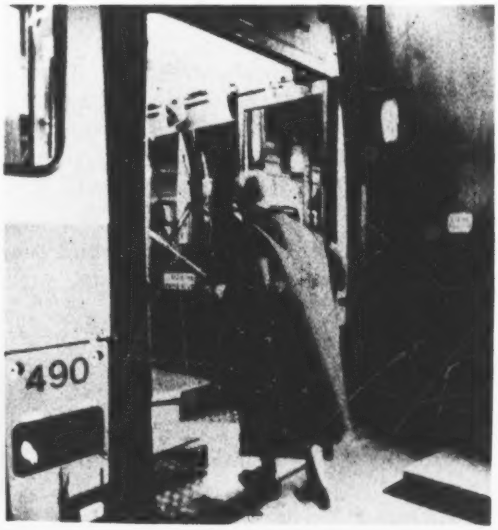


Figure 3

At ordinary bus-stops the curb often does not give the expected "help" to mount the bus. The height of the curb is expected to be at least 100 mm which would decrease the first step to around 250 mm. The real situation however is often to the contrary, (see Figure 4).

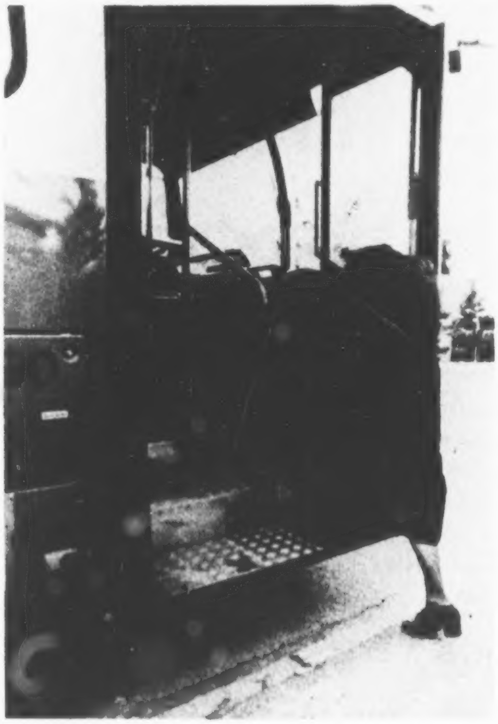


Figure 4

The height of the curb is not more than 50 mm. The situation is further aggravated due to the fact that the bus does not stop close enough to the curb. This can result in not only a high step but also in "long" diagonal step. The adapted bus makes entering much easier, with no special strain in this case. As can be seen in Figure 5, the extra step has another valuable function—it "fills up" the distance between the bus and the curb. In this case, stopping close to the curb does not have much importance since the extra "long" step for the elderly is eliminated. Another technical solution for a low step (200 mm) has become more popular among bus companies, namely, use of the kneeling bus. The advantage with the extra step discussed above is eliminated by the kneeling bus solution.

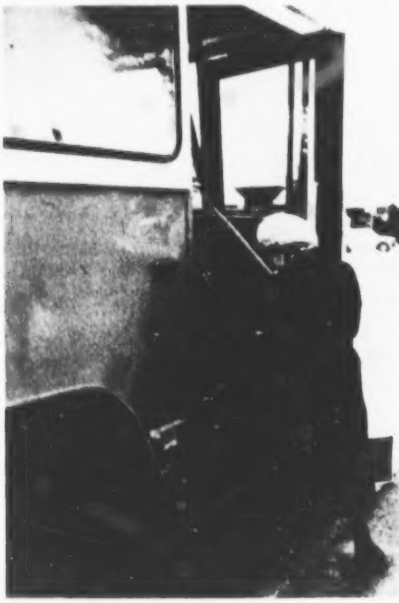


Figure 5

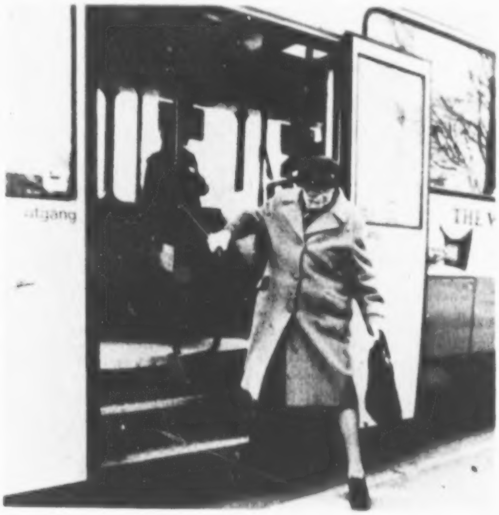


Figure 6

For most elderly with difficulty in ambulation, exiting a bus is more difficult than entering. Contributing factors are the height and the distance between the bus and the curb (see Figure 6).

Figure 7

For the bus-driver it is even more difficult to bring the rear end of the bus close to the curb than the front. In Sweden, exiting the bus takes place through a rear door. For exiting an extra low step would therefore have even more importance for a person with physical decline (see Figure 7).

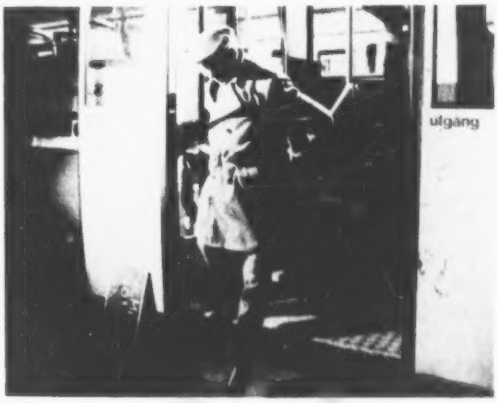


Figure 8

The difficulties in exiting an ordinary bus are also as a result of poorly designed handrails. As can be seen in Figure 6, the handrails are placed too far from the point of exit. In a situation where the greatest need for support is required, i.e., the step down to the curb, the placing of the handrails is inappropriate (see Figure 8). This

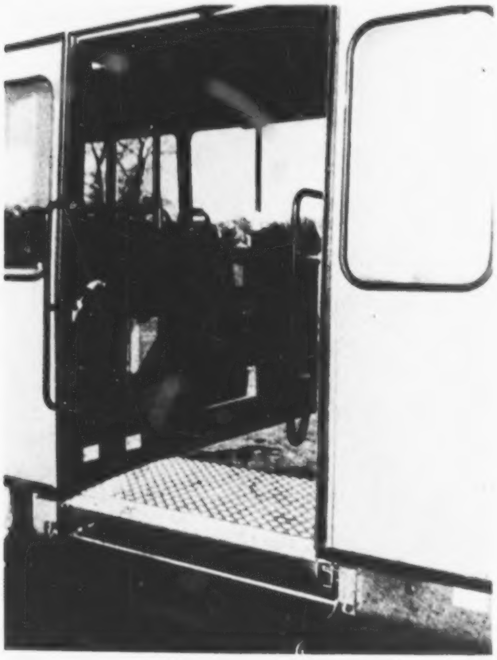


Figure 9

makes a person dependent on some support, "hanging" in the air with one's hands behind the body. Handrails which lead to a point outside the bus is a much better solution (see Figure 9)

3. *Discussion*

An (extra) low step was found most satisfactory for a person with physical problems, on entering and exiting a bus. The handrails however, must be extended outward to give the right support while exiting.

All persons participating in the experiment found the adapted bus much more comfortable to enter and exit than the ordinary bus. This was mostly due to the low first step and the equidistant height of the steps.

Regulations for buses by the Swedish Board of Transport are without a doubt beneficial to the elderly and disabled. Unfortunately these regulations only dictate the technical part of the problem; there is another important side of these problems, namely the interpretation and execution of such rules by all parties involved, such as operators, bus drivers and passengers in addition to the elderly and disabled.

From this study it can be argued that in order to give those groups in society who are most dissatisfied with transport facilities better transportation alternatives that provide a measure of security. Therefore it is important that steps taken to adapt the buses for elderly and disabled persons must include clear instructions about their implementation. If implementation of such regulations is left solely to the driver's discretion, the security and safety which is so important ot groups who have difficulty travelling by public transport may be lost.

Study of Behaviorial Aspects

As was pointed out in the prior section, one of the results from the research concerning adaptation of public transport is that the problems experienced by the elderly and disabled cannot be solved solely by technical solutions with respect to modifications of vehicles. There is another important side of the problem, namely the behaviorial aspects.

There is a lack of consideration and understanding on the part of bus-drivers and other passengers pertaining to the special needs of elderly passengers. In our opinion, such deficiencies in behavior can be just as problematic for the elderly bus passenger as are technical deficiences of the vehicles.

In order to see if more considerate behaviour by bus-drivers would make buses more accessable to the elderly, an applied study in one small Swedish town (about 60,000 inhabitants) was carried our and evaluated in the winter of 1983/84. (Stahl, 1984b)

1. *Study Methodology*

The study was carried out in a geographically defined area. Using a mail survey, half the population aged 65 years or more in this area, some 600 persons, were asked about public transport in that area. That is, what were problems they experienced and what did they require as bus passengers.

Bus-drivers in that particular area were interviewed, to ascertain how they viewed elderly passengers and what were the main problems for elderly passengers traveling by bus.

From this mail survey of the elderly and from the bus-driver interviews, a list of behaviourial issues were selected to be investigated in the applied study which followed.

These issues, involving actions by the bus driver, were as follows:

- bringing the bus closer to the curb
- not starting the bus until the elderly have taken their seats
- assuming that seats reserved for the elderly are freed for the elderly
- announcing forthcoming bus-stops
- allowing sufficient time at each bus-stop so that the elderly do not have to leave their seat until the bus has stopped
- permitting elderly to exit through the front door.

The actual study involved two phases. In the first phase, the bus-drivers in the area studied were interviewed for one hour and advised about the upcoming study—

what would be expected of them, (the list above) and were given general information concerning the special needs of elderly bus-passengers. At the same time a pamphlet was sent to all elderly in the area informing them of the study, i.e., for a period of time they could expect "better bus service for elderly". This pamphlet drew attention to bus-drivers' behavior as well as a statement of support from the local bus company concerning their elderly passengers.

One week after the information campaign, the second phase began which consisted of 6 months of experimental bus service. One month after this experimental period was initiated, all eldlerly and bus-drivers were contacted, the elderly via a mail survey and the bus-drivers by re-interview.

It should be remembered that approximately half of the elderly population in the area were involved in the pre-experimental mail surveys. Since all the elderly we:e sent the post-experimental survey, it was possible to gauge the potential effects of participating in both phases of the study.

2. *Study Results*

Around 50 percent of the elderly chosen for the study answered that they travelled regularly by public transport. In the pre-experimental phase less than 50 percent admitted to some kind of problems when travelling, while in the post-experimental phase almost 70 percent of the same elderly admitted to problems. The higher figure in the post-experimental study might be explained by the fact that the elderly respondents knew the aims of the study and were aware of behavior that could be expected from the bus-drivers. This is supported by elderly who were sent the second survey, and cited similar problems.

What follows are some details on the comparisons between the pre- and post-experimental surveys and comparisions between the elderly who were sent both the pre and post-experimental mail surveys (called Group 1) and elderly who were sent only the post-experimental survey (called Group 2). The post-experimental survey included a question about whether they thought improvements had taken place during the 6 month experimental period on the specific problems being investigated.

With regard to entering the bus about 40 percent of all elderly reported improvement during the experimental period. This was mainly due to the bus stopping closer to the curb or improved snow-cleaning at bus-stops. The elderly also found themselves under less stress on entering the bus. Between the two groups, Group 2 (those receiving the post-experimental survey) seemed to be a bit more positive than Group 1. There were some differences though between the groups on reporting improvements regarding entering the bus. For example, Group 2 pointed more towards improved snow-cleaning while Group 1, to a great degree, cited the bus stopping closer to the curb. This is worth mentioning because perceived improvements may often be attributed to different factors even within a similar group of people.

With regard to exiting from the bus the uncertanty concerning the opening/closing of the back door was somewhat lower during the experimental period. In both groups participating in the post-experimental survey about 30 percent admitted to improvements concerning this feature.

Measures taken by bus-drivers during the bus-journey showed a perceptive improvement during the experimental period. More than 50 percent of all elderly reported that they usually were able to use the seats specially marked for the elderly. Many said however, these seats were denied to them because other passengers had taken those seats. It appeared the drivers had a hard time enforcing this particular feature.

During the experimental period 50 percent of the elderly in groups 1 and 2 indicated that the driver did not depart from the bus-stop until they had taken a seat, compared to 30 percent in the pre-experimental survey (Group 1 only). In this area, 60 percent of all the elderly in the post-experimental survey reported an improvement.

Concerning the opportunity to remain seated until the bus has stopped at a bus-stop, it appeared that this measure was not effectively executed by drivers. About 20 percent of the elderly indicated that during the experimental period, they had to leave their seats before the bus stopped. This was also the case in the pre-experimental survey (Group 1) where 20 percent also reported they had a similar experience. In fairness the drivers are not solely to blame here. Many elderly are very anxious to disembark in good time, which can not be attributed to the driver's actions. Nevertheless, almost 40 percent of all the elderly said the opportunity to remain seated improved.

A desire to have the bus-stops announced was higher for elderly in Group 1 after the experimental period. This was supported by Group 2 who also reported a similar desire in the post-experimental survey. Thus, 90 percent of the elderly reported a desire for this service feature.

On the general question whether the elderly found it easier to travel during rather than prior to the experimental period, almost 60 percent in both groups answered affirmatively and 15 percent of these reported considerable improvement.

3. *Discussion*

It was apparent that the attitude among most elderly and bus-drivers concerning the experimental period seemed to be positive. Bus-drivers it seems, need to be motivated to deal appropriately with the elderly. In many situations they lack understanding of the problems of the elderly which accounts for their behaviour. To what extent all measures for change were carried out by all bus-drivers is difficult to say. In the interviews after the experimental period, most drivers showed a positive attitude when asked whether they had been able to carry out the suggested changes. Most of the drivers claimed they followed the proposed recommendations and were still doing so.

The implementation of one suggestion, namely, announcing of bus-stops, leaves much to be desired.

This is an important service to bus passengers, especially during the long dark winters in Sweden. Bus-drivers do not seem to want to do this and find reasons for not doing it, For example, drivers claimed, "announcing the bus-stops requires too much attention and can present a traffic safety problem".

Results from the post-experimental survey with the elderly seemed to confirm the problems concerning pre-announced bus-stops. This was the only area where the elderly's desire was higher after the experimental period than in the pre-experimental survey. Other perceived problems seem to have decreased.

If travelling by bus is to be positive for the elderly it is important to instill a degree of security in the process, i.e. they should be able to expect regular execution of the measures discussed in the study. The best way of achieving this is by effectively motivating the drivers; making them aware and sensitive to the special needs of elderly using public vehicles. Successful motivation is a complex task which obviously involves many factors—the personality of the driver, a sympathetic understanding of the elderly, the particular environmental circumstances of the bus journey (number of passengers, weather, etc.); and last but not least, the attitude towards the elderly taken by the bus companies who have the authority to make such demands of their drivers.

Nevertheless, the conclusion from this study must be that the travelling situation for the elderly can be improved through behaviourial change on the part of bus-drivers.

Conclusions

The importance of public transportation for the elderly is clear. The quality of public bus service can have an impact on the quality of an elderly person's life. The bus can be the major factor affecting an aged person's participation in recreational activities and in social and family contacts. For many, the walk to and from the bus stop may be their daily exercise.

In Sweden, elderly persons represent one of the largest "special needs" groups using buses. Their special needs as bus passengers for the most part stem from the effects of physical decline in old age. Fortunately, these special needs have been studied and we have a fairly good picture of what problelms are most critical for the elderly bus traveller.

When investigating the elderly using public vehicles, one must take into account their journey to the stop, shelters and benches at the stop, entering the bus, finding a seat, announcement of bus stops, and lastly, the all important exit from the bus. Since we are aware of the problems, the next obvious step is to find and execute suitable solutions to these problems. The present paper highlighted some of the efforts currently being tested in Sweden. We suggest there are both technical and behaviourial aspects to solution of the elderly's public transport problems.

In our opinion, this technical vs. behaviourial issue is most critical and demands more careful research. The entire situation can not be adequately solved by technical means—many of the problems which seem entirely technical at first glance, turn out to have a very important behaviourial component.

We feel there is much to be gained from emphasizing improved behavior on the part of the bus driver. Behaviorial changes on the part of the drivers are not only practical in economic terms but such changes have important implications for the psychological qualities of the elderly person's experience as a bus passenger resulting in increased security, improved safety, perhaps even such subtle benefits such as feelings of increased self-worth. A good next step is to study carefully the best way to incorporate such behaviourial changes into the bus-driver's training.

References

Stahl, A., 1984(a). Elderly people in the traffic system. Department of Traffic Planning, Lund Institute of Technology, Lund, Sweden.

Stahl, A., 1984(b). Improvement of public transport to the benefit of elderly people. Department of Traffic Planning, Lund Institute of Technology, Lund, Sweden. (Summary in English).

Stahl, A., 1983(a). Special transport systems in the municipalities. Department of Traffic Planning, Lund Institute of Technology, Lund, Sweden. (Summary in English).

Stahl, A., 1983(b). Adaptation of buses to the benefit of disabled. Department of Traffic Planning, Lund Institute of Technology, Lund, Sweden. (Summary in English).

Swedish Board of Transport, 1983. Regulations for the adaptation of public transports, Solna, Sweden. (No English summary).

Agneta Stahl, Department of Traffic Planning and Engineering, Lund Institute of Technology, University of Lund, 221 00, Lund, Sweden.

CANADIAN DEVELOPMENT IN VEHICLE TECHNOLOGY FOR TRANSPORTATION OF THE PHYSICALLY HANDICAPPED

Ling Suen and Peter J. Kaulback

Introduction

For years the major barrier to integration of physically disabled persons was the difficulty in making a journey; consequently, accessibility to "line haul" aspects of transportation systems has been the focus of considerable attention. The net result of these efforts is that the weak link now lies in the access, egress and ancillary modes. Improvement to these modes might not be viewed to be as glamorous as improvement done to aircraft, buses and rail coaches but they are nevertheless the necessary elements towards total accessibility.

This paper describes the concept of a complete mobility continuum, and outlines developments, both in vehicle development and related systems research, that have been undertaken in Canada. A direction for future research is proposed.

The Concept of Complete Accessiblity

To date, efforts in improving existing transportation systems for the physically disabled have tended to adopt a somewhat disjointed "vehicle specific" rather than a system-wide approach. When accessibility has indeed been attained on certain vehicles, system implementors were often disappointed by infrequent utilization due to barriers in the access, egress and transfer modes. The words "access" and "accessibility" have often been interpreted with very limited spatial and temporal implications: a fully accessible bus, to most people, is one which a handicapped person can board and alight. There is very limited value in providing an accessible bus, if access to and within the terminal, and not only onto the vehicle, is not provided. The provision of this expanded access may be considerably more difficult than the technological solutions required in providing access onto the vehicle, and may require integration of efforts from many sectors. Accessibility must therefore be thought of in terms of the entire transportation system, origin to destination, rather than segmentally.

Graphically a trip resembles a series of links of various strengths forming a chain: the weak links are the current barriers to the successful continuation of the journey. Complete accessibility means that all links in the chain must be of equal strength. The previous situation, current and ultimate are depicted in Figure 1. This diagram shows that there are still gaps in all of the trip types to be overcome; however, the urban/rural trips are probably the closest toward attaining complete accessibility, the ultimate objective.

The travel mode used by the physically handicapped obviously varies as a function of distance. Similarly, vehicle capacity varies with distance, the capacity increasing

FIGURE 1

DIAGRAMATIC REPRESENTATION OF ACCESSIBILITY GAPS

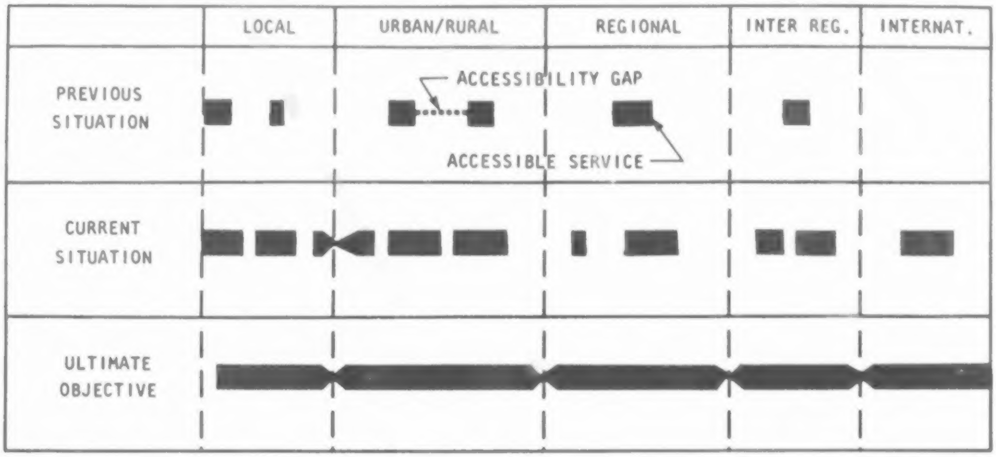
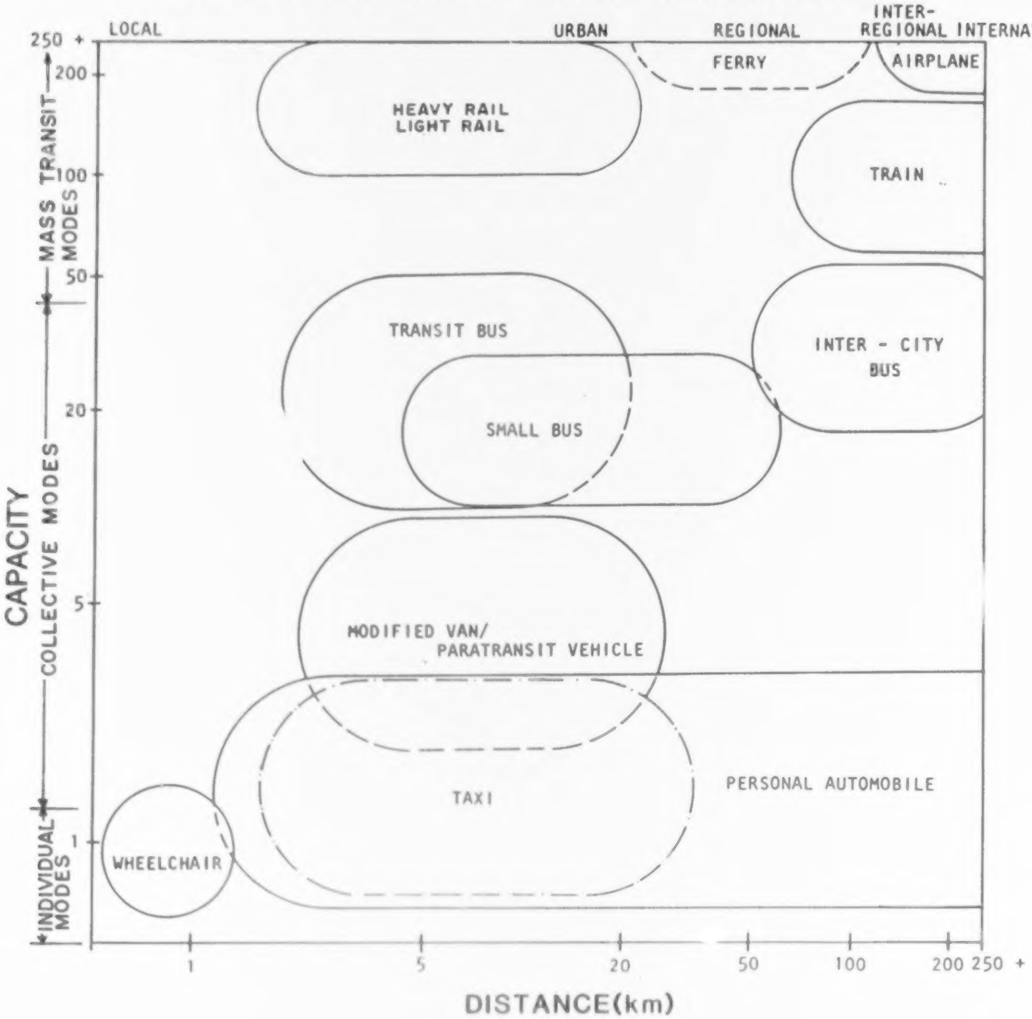


FIGURE 2
RELATIONSHIP OF CAPACITY & DISTANCE
IN TRAVEL MODES FOR PHYSICALLY HANDICAPPED



as distance increases. A diagramatic presentation of the interrelationship between distance and capacities is shown in Figure 2.

Most research in recent years has concentrated on mass transportation and its accessibility. In the United States, the issue regarding federal legislation of transit vehicle accessibility has drawn attention to this area. Along with transit vehicles, research funds, both in Europe and North America, have also been expended on smaller vehicles, from small buses to a wide range of paratransit vehicles while less attention has been paid to individual travel modes such as the private automobile notwithstanding its great flexibility in travel range. At the other extreme, political pressure has had a strong influence in increasing accesibility on major interregional and international modes. Railway and airlines have made considerable improvements in accessibility in many countries. To a certain degree these improvements have not been fully utilized due to weak links in some segments of the accessibility continuum, however progress in this area is generally commendable.

In Canada, the majority of federal funding has been allocated to those travel modes over which jurisdiction is most direct. Less emphasis has been given to those areas under provincial jurisdiction, and notably little attention paid to individual travel modes. Most developments in this later category have been the result of entrepreneurial enterprises attempting to fill a perceived market void. The greatest paucity of funding is evident in the transfer modes between line haul functions.

Canadian Developments

Canada has recently made big strides in increasing accessibility on those modes, such as air, rail and interregional bus, that are federally regulated. These modes may not necessarily be the ones most frequently cited as barriers to trip completion, nor offering the greatest opportunity for increased mobility. Some efforts are devoted to the private auto and transfer modes despite a relative lack of jurisdictional responsibility. A selection of completed or ongoing research is given below.

Individual Modes

As previously mentioned, the individual modes have generally been addressed by private enterprise and have benefitted only recently from larger sums of public funding. An exception is the Canadian development of a curb-climbing wheelchair (Rutenberg, 1978) which has previously been widely publicized. This development is currently in the hands of a commercial producer and, provided that sufficient demand exists, may be available on the market in the future.

The Transportation Development Centre of Transport Canada is undertaking research on a wide variety of nonconventional wheelchairs available in the marketplace, and the appropriate licensing and regulatory framework that should be applied. The design and performance gap between the wheelchair and the automobile has, in recent years, been filled with many "hybrid vehicles" to which few exisitng regulations apply. It is important for the safety of all that operating criteria be established that are consistent with the capabilities of individual vehicles. This is an issue which other countries must also tackle in the near future.

The ultimate in urban/rural and regional travel flexibility is afforded by the automobile. Canada has recently undertaken a comprehensive evaluation of an English vehicle, the Elswick Envoy (Fernie, 1983), designed to be driven from a special wheelchair. Tests were conducted to determine the vehicle's conformity with Canadian Motor Vehicle Safety Standards. An extensive ergonomic evaluation designed to determine the vehicle's suitability as a personal vehicle for Canadian disabled drivers was also carried out. It is hoped that this vehicle, which is now being imported into the United States, will benefit from the extensive mechanical and ergonomic tests, and that appropriate modifications will be made to the advantage of the physically disabled community. See Figure 3.

Physically handicapped persons who are capable of driving are often greatly inconvenienced during their travel since they were unable to rent a suitably equipped vehicle. The requirement for a complete set of easily attachable hand controls (Nicklin, 1982) was identified by Transport Canada as an area of valid research. A prototype system has been developed and is now being tested at car rental concessions in Ottawa, Ontario, and St. John's, Newfoundland. The system attaches to the brake and gas pedals, the floor and the steering column yoke. Four locking pins permit installation in two minutes and complete removal in less than one minute.

Research is currently being undertaken by Transport Canada's Transportation Development Centre into vehicle selection guidelines for handicapped persons. More information is needed to assist handicapped people to evaluate the suitability of conventional production automobiles for their personal use. When this research is complete, and the information made available, many persons who previously thought that no vehicle was adaptable to their specific needs may find a suitable and affordable automobile and hence attain greater travel freedom.

Collective Modes

A Canadian firm, with limited public funding, has made notable advances in the area of developing a small

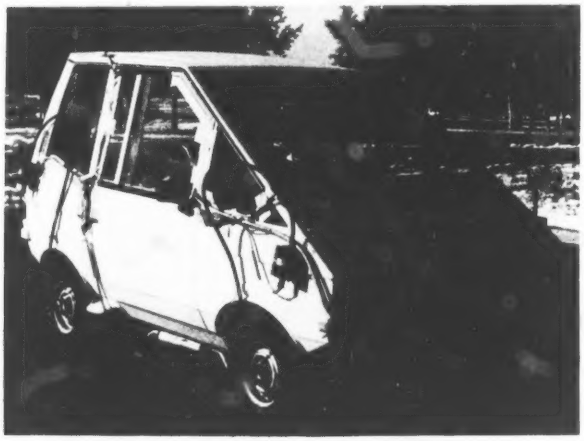


Figure 3

Figure 4

paratransit vehicle. The GSM Taxi (1983), a vehicle capable of carrying one wheelchair passenger, was developed by a Montreal firm. Efforts are currently underway to produce the vehicle in volume and to equip taxi companies across the country with those fully accessible vehicles. (See Figure 4.)

In order that pertinent information might be available to paratransit vehicle regulators, operators, and developers, guidelines were developed pertaining to selection of these vehicles (Kaulback and Eryou, 1982). It is hoped that dissemination of knowledge of this type will assist in attaining consistent regulations in different jurisdictions, and will assist vehicle developers to more accurately meet the market requirements of the physically disabled travelers.

A significant Canadian development receiving wide acclaim is the fully accessible small transit vehicle Orion II. This small bus, built by Ontario Bus Industries (OBI) of Mississauga, Ontario, and supported by the federal Department of Regional and Industrial Expansion, incorporates extensive advanced technology and can carry up to seven wheelchairs with random access. The vehicle is equipped with kneeling suspension and is accessible from both the rear and the side. The Orion II is a sophisticated vehicle and is priced accordingly; however, it is still less expensive than European vehicles such as Steyr and Neoplan. The Orion II is selected as the vehicle for paratransit services for a number of transit properties and is currently being evaluated in service by the State of Michigan. (See Figure 5.)

Research has been undertaken in Canada on accessibility on intercity buses, particularly those under federal regulation, although the technology can equally well be applied to other intercity services. In 1981 the Canadian Transport Commission conducted an inquiry into bus service for the disabled in Newfoundland (Fleming and Silverstone, 1981). A subsequent Parliamentary Committee recommendation requires that this bus service, Roadcruiser, provides a mechanical system to board wheelchair passengers on its MC-9 intercity buses. As a result, Transport Canada is committed to a three year demonstration of an MC-9 bus made accessible with the installation of an innovative internal elevator system called "EL-Lift" (Wagner and Kryski, 1984) and has a specially designed wheelchair restraint system on board. The El-Lift is hydraulically actuated, incorporates microprocessor technology, includes a message center to assist the driver in the system's operation and provides limited diagnostics. The space below the lift platform can be used for storage of baggage. The MC-9 with its EL-Lift system is scheduled to arrive in Newfoundland December 1984 to begin the three year demonstration. The demonstration results will help determine the adequacy of this technical solution to intercity bus travel. Findings will also be used to determine accesibility standards for the Roadcruiser service.

Transportation for handicapped persons who live in rural areas receives relatively little attention. The practicality and cost-effectiveness of specialized services in rural areas is severely limited due to the sparse population and greater distances to be traversed. In many rural areas, the ambulance service, for example, is severely underutilized but must still be maintained as an essential service. It has been proposed that a multi-purpose vehicle (Wallace and Rea, 1984), capable of carrying stretchers, wheelchairs and ambulatory passengers could also be used to provide transit services in addition to being an ambulance. The Province of Manitoba is examining the feasibility of providing such combined services.

Another area recently investigated in Canada is the question of a group transportation vehicle (Kaulback, 1984) for the physicaly handicapped. Currently there are very limited vehicle options available for institutions such as rehabilitation centres, hospitals, group associations, etc., for the handicapped, to transport relatively large numbers of wheelchair passengers due to the extensive elapsed time required for loading and unloading. A study

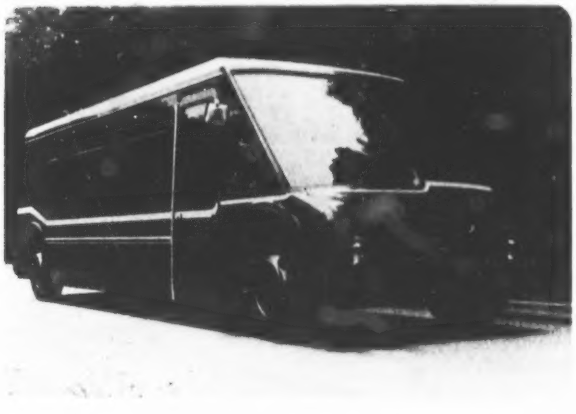


Figure 5

FIGURE 6
DISABLED GROUP TRANSPORTATION VEHICLE

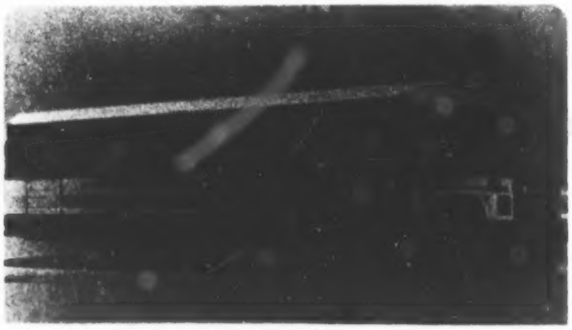


Figure 6

was undertaken to determine the advisability of developing a purpose-built group transportation vehicle for wheelchair passengers. The conclusion was that no one vehicle type would be appropriate for a sufficient number of users to justify special production models. A modification of the standard school bus was proposed. These vehicles, available in a wide range of sizes, are sturdy and reasonably inexpensive. With appropriate modifications, they can be made more attractive by means such as window treatments and exterior painting. (See Figure 6).

Mass Capacity

To a large degree, developments in this category have been modification of existing vehicles rather than the development of entirely new vehicles. For example, commercial aircraft are generally able to carry wheelchair passengers, especially those capable of transfering to an aircraft seat, but modification such as accessible washrooms and removable armrests are steps in the right direction.

Transport Canada is currently funding a study on access to commuter rail services for disabled persons. Commuter transportation in Canada has, to date, relied upon parallel services provided by transit operators rather than adopting the integrated approach. The research currently underway investigates the feasibility of a partially integrated solution, with some fully accessible vehicles and facilities on selected routes, using two systems in Montreal and Toronto as case studies.

Access to intercity trains has been the subject of Canadian research. A number of station-based lifts have been built, and are now in use at VIA Rail stations (VIA Rail, 1981) by means of which a wheelchair passenger can board or alight from the train within a reasonable time (see Figure 7). An onboard lift has also been studied and is in the final stages of prototype design.

Modal Interfaces

As has been previously mentioned, the provision of an accessible vehicle is of limited value if difficulty is encountered in the terminals. This problem is particularly acute in the large transportaton terminals where long walkways and level changes are major impediments to the handicapped traveler.

One exciting Canadian development with applications in transportation terminals is the Small Carrier for Alternative Transportation (SCAT) (Rutenberg and Barber, 1982). The device is a modular transfer vehicle developed for both indoor and outdoor use in terminals and other sites such as pedestrian malls and public concourses. The vehicle consists of a motorized platform to which can be added one or more non-motorized modules. The vehicle is made accessible by a ramp and can transport wheelchair passengers, thus reducing the work of attendants.

Transport Canada is now evaluating the use of stairway lifts in transportation terminals. This type of lift is currently in use in three airports, a ferry terminal and a railway station (Kaulback and Heron, 1984). (See Figure 8.) Research on these devices indicated that they do indeed facilitate transportation for handicapped persons although drawbacks exist. Inclined stairway lifts are generally slow and have specific ergonomic shortcomings. Where possible an elevator is a preferable option to stairway lifts.

Conclusions

Considerable research, both in Canada and elsewhere, has been undertaken in recent years on transport for the physically handicapped. However, we are at a considerable distance from attaining a fully accessible continuum. Fully accessible trains are not yet available, many air terminals are difficult to traverse and bus travel is fraught with problems for the handicapped traveler.

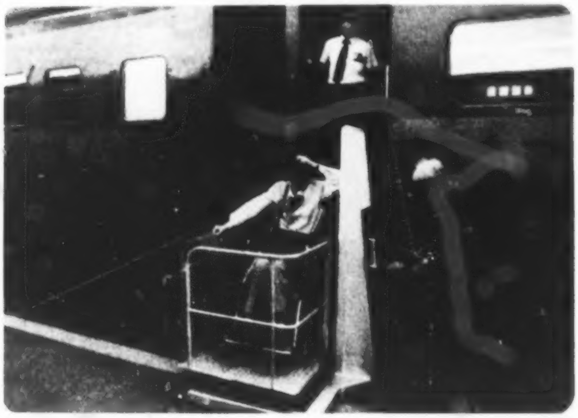


Figure 7

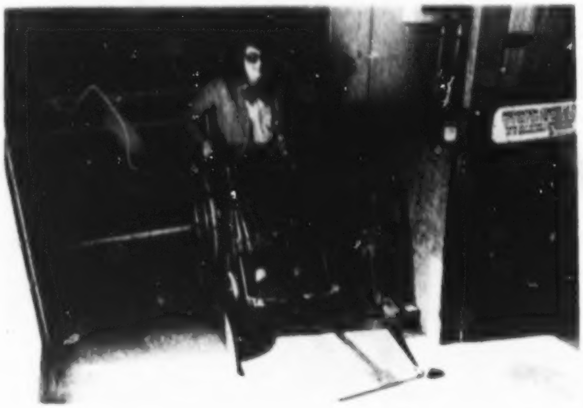


Figure 8

Future research, while not neglecting the gaps in the current travel sequence such as transfer and ancillary modes, should empahsize the "private" modes. To date, the amount of research undertaken on accessibility and use of automobiles by the handicapped is in no way proportional to the potential benefits of this mode by virtue of its flexibility. The automobile frees the traveler from schedules and, at the same time, gives the driver the opportunity to express self sufficiency. Although it is acknowledged that transit and commuter rail are important, the availability of suitable private vehicles for operation by the handicapped would increase their transportation freedom more than any other development.

After more than ten years of work in this area, the needs of the wheelchair users are relatively well defined. The new challenge is to develop vehicle and associated technologies to address the needs of the elderly and the visual/hearing/speech impaired and the cognitively handicapped. Further efforts must be made to integrate other handicapped groups into mainstream transportation.

References

Fernie, G.R., An Ergonomic Evaluation of the Elswick Envoy. West Park Research, Toronto, Ontario, Canada, September 1983. (TP 4939E)

Fleming, M.S. and Silverstone, D.B., Report of the Inquiry Respecting Intercity Bus Service to the Disabled in Newfoundland. Canadian Transport Commission, Ottawa, Ontario, Canada, December 1981.

GSM Taxi. Guillon, Smith, Marquart and Associes Ltee, Montreal, Quebec, Canada, December 1983. (TP 5078E)

Kaulback, P.J. and Eryou, N.D., Paratransit Vehicle Technology Guidelines for Regulators, Operators and Vehicle Developers. DeLeuw Cather Canada Ltd., Ottawa, Ontario, Canada, May 1982. (TP 3648E)

Kaulback, P.S. and Heron, R., Stairway Lift Assessment: An Evaluation of Selected Automated Inclined Stairway Elevating Devices for Transportation Terminals. DeLeuw Cather Canada Ltd., Ottawa, Ontario, Canada, March 1984. (TP 5290E)

Kaulback, P.J., Disabled Group Transportation Vehicle: An Evaluation of User Demand, Vehicle Requirements and Funding Sources. DeLeuw Cather Canada Ltd., Ontario, Canada, April 1984. (TP 5291E)

Nicklin, J., Quick Release Hand Controls for Automobiles: Prototype Design and Evaluation. Davis Engineering Ltd., Ottawa, Ontario, Canada, June 1982. (TP 3779E)

Rutenberg, U., The Design and Development of a Curb Climbing Electric Wheelchair. Ball Berezowsky Associates, Ste. Anne de Bellevue, Quebec, Canada, June 1978. (TP 1500)

Rutenberg, U. and Barber, M., Travellers with Special Needs: Modular Transfer Platform Design Concept. Les Designers Douglas Ball Inc., Ste. Anne de Bellevue, Quebec, Canada, 1982. (TP 3796E)

Via Rail's 5 Year Program for Passengers with Special Needs. VIA Rail Canada, Montreal, Quebec, Canada. 1981.

Wagner, P.W. and Kryski, L., Preliminary Engineering Design of an Elevator-style Access Device (the EL-Lift) on an MC-9 coach. Lugano Enterprises Ltd., Winnipeg, Manitoba, Canada, January 1984. (TP 5213E)

Wallace, J. and Rea, John C., Multipurpose Vehicles as a Solution to the Need for Transportation of the Elderly and Handicapped in Small and Isolated Communities. Manitoba Department of Highways and Transportation, Winnepeg, Manitoba, Canada, August 1984.

Ling Suen, Acting Deputy Director, Program Planning and Support, Transportation Development Center, Transport Canada, Complexs Guy Favreau, Suite 601 West Tower, 200 Dorchester St. West, Montreal, Quebec, Canada H2Z 1X4.

Peter J. Kaulback is a Consultant with DeLeuw Cather, Canada Ltd., Ottawa, Ontario, Canada K1G 3H6.

TRAINING THE TRANSPORTATION HANDICAPPED TO USE PUBLIC TRANSIT

Cathleen E. Towner

Intorduction

It has been assumed that for most people with disabilities public transit is not a viable solution to their travel needs. Their disabilities prevent them from having the skills needed to plot a route, read transit directions, identify landmarks, manoeuver crowds, and undertake travel as other members of society. Lift-equipped buses or para-transit seemed the only feasible, if expensive, solution to making public transit accessible thus meeting the mandate of Section 504, the Rehabilitation Act of 1973. Actually those with vastly different types of disabilities are prevented from meeting their travel needs not solely by reason of disabilities but in large measure becasue they have not been expected, or taught how, to travel.

This paper will examine the use of mobility training as a means of making public transit accessible to many persons with disabilities. It will discuss the unique approach to mobility training developed in Rochester, New York. Lastly, it will present some ideas for expanding use of public transportation resources through generic mobility training.

Throughout the 1970's it was believed that persons with physical disabilities were the only individuals unable to use public transit. The need for independent travel by people with other types of disabilities was not an issue. This was perhaps the result of the long term institutionalization of many persons suffering from retardation, epilepsy, blindness, mental health problems, and cerebral palsy. These disabilities by their very nature precluded using public transit. Travel by bus was too complicated and dangerous for individuals perceived to be unsophisticated and fragile. Those with other neurological, health, or hearing impairments were not considered since their needs were even less apparent. During this period, the ability to travel was understood to be something everyone knew how to do. It was not an acquired skill except for people with blindness.

The need for the congentially blind or persons with acquired blindness to travel has been of concern for many decades. Certified Mobility and Orientation Specialists have been instructing the blind to travel independently with the aid of a white cane or guide dog. The blind have learned to travel because it was viewed as a skill they could acquire. Their blindness was viewed as a travel barrier but one that could be overcome. Sadly, except for some persons with moderate retardation, this functional approach to meeting travel needs had not been generalized to persons with other disabilities. We agreed that if the individual with a disability could not travel, it was because they had a disability; to expect more seemed both cruel and unrealistic.

The Community Mobility Program

In 1979, in Rochester, New York, a unique experiment was launched. Funds obtained from the Federal Highway Safety Administration were being used to develop a demonstration which applied the concepts of traditional mobility training for the blind to any form of disability or transportation handicap. In this generic approach, skill was the key. The ability to travel as a pedestrian, a public transit user, or a bicyclist was accepted as a skill which could be taught and learned. Three modes of travel were analyzed. Each step or task was sequenced; a behavioral objective written; and a method for teaching described. This process resulted in a series of achievable goals that reinforced success throughout the learning process. The nature or cause of the skill deficit was relevant only in selecting different teaching methods. This curriculum was generic because it used the existing public transit system, as the primary teaching tool for individualized travel skill training. Differences caused by specific disabilities were accommodated in the teaching process. The curriculum, evaluation, and teaching program were adaptable to any type of disability. The training process was consistent for anyone referred and included evaluation, individual program development, orientation and mobility training, and post-training survey, each of which are discussed below.

The evaluation process was used to predict the probable success of the individual based on one's competence in a few key prerequisite skills and a commitment to acquire the skills for independent travel. The evaluation occurred in the community along the route(s) most likely to be traveled. All those referred were evaluated for their competence as pedestrians and then when indicated, as public transit or bicycle users. Additionally, the support of the family or "significant other" and the value of travel goals to the learner were carefully assessed. The desire to travel independently often overcame barriers caused by disability, lack of experience, skill, or naivete. The evaluation was on a pass-fail basis. Those demonstrating adequate skill in manual dexterity, the concept of danger, the ability to follow three part directions, and socially acceptable behavior defined as, "the lack of extreme expression of any behavior which causes harm to self or others" were admitted into training. Those failing were recommended for a more appropriate type of transportation, such as a taxi.

The training process began with the development of an Individual Training Program (ITP). Since most individuals referred to the Community Mobility Program had never traveled independently before, they were unfamiliar with the demands made by schedules, time, inclement weather, or bustling crowds. The trainee learned the requirements of travel, i.e., getting up on time, dressing apropriately for weather conditions, having the correct fare, and being at the bus stop on time. These new expectations were quickly incorporated in the trainee's daily routine. In addition to these orientation skills, the trainee had to acquire specific mobility and mode skills, e.g., how to use pedestrian safety aids, identify a landmark, or plan a route to a desired destination. These objectives were individualized in the curriculum and included in the ITP. Any unique learning needs, such as, deficits in depth perception or short-term memory, inability to read or speak, poor associative skills, or number recognition, were accommodated in the teaching process.

Since learning to travel independently requires a great deal of effort, all trainees had to have a clearly identified goal for travel at the time they began training. The goal had to be something the trainee valued, usually a job, a training program, or a therapy session. They also had to make the commitment to travel at least three days per week. Both these conditions aided trainees in re-orienting their daily routines to include responsibility for one's own transportation.

One of the most important skills a trainee had to acquire was how to cope with being lost. Four methods of coping with being lost were taught:

1) telephone for directions;
2) ask the bus driver for help;
3) ask a policeman for help;
4) stay on the bus.

These methods were practiced and applied in different situations. The trainee was expected to gain competence in all methods except where counter-indicated (non-verbal trainees did not use the telephone). Post-training survey data indicated that, when lost, former trainees employ the methods they were taught. Some generalize their skills and use their own solution, like walking home.

Some trainees needed special aids like a travel book or route card (for persons who were non-verbal or hard to understand.) These aids were individualy prepared and the trainee taught to use them when asking directions or seeking help from a bus operator or police officer.

Throughout the average 18 to 24 hour training process, the trainee gradually assumed total responsibility for his/her travel. One-to-one instruction occurred on consecutive days over a two week period. Each training session included a two way trip. The mobility instructor began training by demonstrating sequential tasks for the trainee, e.g., to cross the street when the walk light lit up. The series of practice sessions required the trainee to assume more and more responsibility for the complete task. Competency was achieved when performance on the objectives reached 100 percent. Of those who entered training, 95 percent completed their training program. Those who had to be discontinued usually fell into two categories:

1) member of a family unable to support the trainee's drive for independence,

2) an inability to achieve 100 percent performance on individual objectives. Most fell into the former, rather than the latter category.

One month following training, a post-training survey was administered to determine how well the new traveler was doing. Data from the survey were used to evaluate the training process for effectiveness and as justification for requests for financial support. (See Table 1)

TABLE 1

Community Mobility Program

Individual Mobility Post-Training Questionnare Results

(193 respondents of the 326 individuals trained during 3/1/80 to 3/31/83)

Travel Skill	*Regulary*	*Seldom*	*Never*	*No Response*
Travel independently as trained	153 (79%)	11 (6%)	24 (12%)	5 (3%)
Punctual behavoir	153 (79%)	1 (1%)	10 (5%)	29 (15%)
Carries indentification	135 (70%)	3 (2%)	16 (8%)	39 (20%)
Uses travel book (if needed) *	38 (58%)	3 (5%)	25 (37%)	

* N = 66

Travel Associated Skill	*Yes*	*No*	*No Response*
Became Lost	17 (9%)	150 (78%)	26 (13%)
As trained, coped by:			
• using the telephone	7		
• talking to police	4		
• talking to bus driver	4		
• walked home	2		

Improvement in Overall Social Behavior	*Yes*	*NO*	*Didn't Know*
	81 (42%)	88 (46%)	24 (12%)

Since June of 1980, when the Community Mobility Program initiated training, over 600 referrals for mobility training were received and of these some 400 have completed training. The post-training data indicates, for those responding, that 87 percent travel regularly; 79 percent are punctual; 70 percent use identification; and only 9 percent became lost at some point. Additionally, "significant others" (families, spouses, residental care staff) report that 42 percent have shown an improvement in their overall social behavior. Comments like "He's more responsible "I don't worry about his handling money anymore", or "Its safe for her to be alone" were made. It would appear that acquiring independent travel skills is a milstone that encourages adult behavior in other desired areas of development. Not only is the individual more in control of his daily life and able to make decisions regarding jobs, social contacts, and recreational activities, but families and the community are free to devote their transportation resources (time, money, creativity) to other uses. For the family, this may mean the ability to allow an adult-child to grow up; for the community it means expending scarce para-transit dollars on those not able to meet their travel needs in other ways. The independent traveler makes no demands on para-transit.

At the beginning of the demonstration, the Community Mobility Program focused its training on those with developmental disabilities as defined in Public Law 95-602. The vast majority of referrals were individuals with mental retardation. It was assumed that because these individuals had specific deficits in cognitive and adaptive skills, only persons at the highest functioning placed, i.e., those with mild mental retardation would be albe to travel independently. Over the last four years, the Community Mobility Program has successfully taught individuals with severe mental retardation and multiple disabilities to travel. This success led to the expansion of the population served to include those with chronic mental health problems, learning disabilities, visual impairments, hearing impairments, epilepsy, neurological impairments, stroke, non-English speaking and the aged. Only those with orthopedic disabilities which prevent ambulation were denied admission to the Community Mobility Program.

The vast majority of those referred to the Community Mobility Program learn to use public transit. The cost of a one way trip on public transit in Rochester is $.70. The cost of a one way trip on Rochester's para-transit service is $7.26, of which $6.56 is subsidized. Community based transportation on agency vehicles is also approximately $7.00 per trip, to which the traveler usually contributes nothing. The Community Mobility Program's average training cost per trainee is $896. Following training the new traveler will spend approximately $360 per year for public transit. This is revenue collected at the fare box. The cost for one year of either para-transit or agency transit is over $3400. Financial support for these services comes from federal, state, and local funds. Resources for such subsidies are strained. Generic mobility training offers a cost effective alternative to costly para-transit for many transportation dependent persons. The recovery in fare box fees for the public transit authority is obvious, bringing a reduction in demand for more expensive levels of specialized transportation. However, the greatest benefit is to the individual who learns to be responsible and able to meet his/her transportation needs.

Informational Programs

Changing the travel behavior of so many persons with disabilities could not have been done without an extensive campaign on the benefits of mobility training to families, rehabilitation professionals, transportation providers, educators, funders, bus operators, and police officers. In the first two years the program was offered, over 2000 people were contacted with information on the Community Mobility Program. An inservice training program to instruct both bus operators and police officials was essential to the success of the generic training in Rochester.

The full participation of the public transit operator and the police department were requested and obtained before the program proceeded beyond the concept phase. Video tapes were produced on those disabilities policy officers were most likely to come in contact with.

Video tapes for the police department were produced on mental retardation, cerebral palsy, and epilepsy. The tapes were no more than four minutes in length. The copy and visuals were developed by the staff of the Community Mobility Program. The tapes were made by police department staff. Editing was a joint responsibility. Since production of the tapes, 465 officers have viewed each of the tapes at least once. To augment the series, live group presentations on the services provided by the Community Mobility Program and the role police officers play in the program are made annually. Officers from the downtown section of the Rochester police department routinely interact with the trainees so they learn to whom to go to for help.

For the Regional Transit Service, the public transit service in Rochester, a series called "Special People Special Problems" was developed. Like the Community Mobility Program itself, this service was expanded to include information on all types of disabilities. All new drivers were required to take the two and one-half hour course. Other programs on specific groups, such as, the aged, were offered throughout the year, but on a voluntary attendance basis. A handbook providing information on the transportation handicapped was produced jointly by the

Community Mobility Program and the Regional Transit Service. This booklet is in its third printing.

The outreach effort of the Community Mobility Program smoothed the way for the newly trained traveler to move into the mainstream of the traveling public.

Self-Sufficiency

Funds from the Federal Highway Safety Administration were allocated on an annual basis for a period of three years. The Community Mobility Program had to develop a financial structure that would allow it ultimately to be self-sufficient. Efforts in this direction began eighteen months into the demonstration, after the effectiveness of the training process had been established.

Possible sources of support on fee-for-service basis were identified. The real cost of the program was computed on an hourly basis. The cost benefit of the program was carefully presented in narrative form. During the next eighteen months the biggest challenge to be overcome was finding a broadly based organization with sufficient resources and willing to assume future administrative responsibility for the program. The Genesee Transportation Council, the metropolitan transportation planning organization, agreed to assume this responsibility.

Four possible sources of funds to support a fee for-service were identified: Medicaid, which pays the cost of transportation for eligible low income clients to Medicaid approved programs; health insurance companies, which pay the cost of transportation to services like occupational therapy; the state Office of Vocational Rehabilitation, which pays for a myriad of services for those with disabilities pursuing a vocational goal; and private fees. The Community Mobility Program was successful in becoming a vendor to the Office of Vocational Rehabilitation. To increase its acceptance as a credible vendor with Medicaid and health insurance companies, a Certified Orientation and Mobility Specialist replaced the original staff lost through normal attrition. Acceptance by these two latter potential funders is yet to be achieved. Some trainees have been privately supported.

Other sources of potential revenue include local foundations who have provided operating funds to the Comunity Mobility Program.

The program's transition from governmental support to self-sufficiency has been a difficult one. The greatest challenge for the program was to diversify its income base. It had to convince various rehabilitation, planning, funding, and governmental units to include the cost of transportation (whether vehicular, transit, or skill training) in their programs and budgets. This approach challenges the widely held belief that those with disabilities cannot assume responsible for their own travel needs.

Expansion of Independent Travel the Goal

The Community Mobility Program has demonstrated that most individuals who are transportation dependent can become independent if that is expected and communicated. The concept of individual responsibility calls for a fundamental change in attitude on the part of the individual, the family, social service providers, funders, the transit authority, and transportation planners. In the past, the approach has been to assume that transportation for those with disabilities had to be provided directly to the individual; since he/she had a disability, the individual was not considered able to assume this responsibility. This approach was logical given our understanding of the potential of those with disabilities for self-sufficiency. Many with disabilities did not work, travel or reside in the community. Society had provided for some of the disabled in large institutions which removed them from normal contact. With the decline of institutions as a solution to the needs of those with disabilities, community expectations for those with severe handicaps has changed gradually. It is now possible to expect those with disabilities to maintain a normal routine, of going to work, to recreation, have social interaction, and to travel. Our solutions to meeting the transportatio needs of those with disabilities must keep pace, with new knowledge. As with other citizens, the responsibility for transportation should lie with the individual whenever possible. His/her ability to be independent should be considered; a continuum of transportation options can be made available with the cooperation of all sectors of the community. The cost of transportation must be included in all programs and services. As with transit, there will be no substantial resources of new dollars to meet the transportation needs of the disabled. Most importantly the responsibility for moving away from transportation dependence to independence must be shared. In this way, those able to use public transit will do so and those oppropriately in need of paratransit programs will gravitate to specialized services.

Cathleen E. Towner, Senior Transportation Planner, Genesee Transportation Council, Rochester, New York, 14614

TRANSPORT USAGE BY THE ACTIVE ELDERLY HOLDING FREE TRAVEL PASSES

P. Truelove

Background

The general rationale for the provision of free or cheap travel for the elderly is well known. Public transport can provide an essential lifeline for the non-car owning elderly. At off-peak times, a use should be found for the buses used at journey-to-work times by fare-paying commuters.

This has provided the basic justification for the granting of free, or reduced fare tickets for the elderly in many large urban areas. One such area is formed by the West Midlands conurbation in the United Kingdom where since 1974 free travel passes have been available to the elderly after 9:30 AM and before 3:30 PM. The West Midlands, which includes the major city of Birmingham, is a conurbation of some 2.5 million population. Formerly a prosperous manufacturing region, heavily reliant upon metal processing industries, it has in recent times become an area of rising unemployment.

Car ownership, once above the national average, has not risen as predicted in the 1960's, and 40 percent of households in Birmingham were without a car in 1981. In recent years, there has been some thinning out of central area employment, leading to a reduction in total travel to the central core. Most public transport usage is by bus, but there are a number of suburban railway lines. Politically, the West Midlands are under Labour control, and the County Council has attempted to upgrade public transport, and to develop the suburban railway network, by improving train frequencies etc.

The provision of free travel passes for the elderly has had a beneficial effect upon bus passenger boarding rate after 9:30 AM, as may be seen from Table 1.

Whilst the "shopping" sector of the passenger transport market has maintained usage most successfully in relation to other sectors (e.g. the sharp decline in evening social travel), there can be little doubt that travel by pensioners has contributed substantially to the strong demand for bus travel between 9:30 AM and 3:30 PM. Since these figures were published, travel during the evening peak has also been made free, with further beneficial effects upon bus usage by the elderly.

Whilst pensioners made up 20 percent of all passengers carried, in the off-peak the proportion rises to 30 percent, (Harris, 1984). Currently, the West Midlands Passenger Transport Executive (WMPTE) carry 1,976,000 pensioners weekly. This is an increase of 190,000 following the change in validity of free passes permitting evening peak hour free travel, which occurred on Jan. 1, 1984. The increase is of 103,000 journeys during the peak, but also 87,000 during the off peak.

The travel passes have been in operation since 1974, and during that period the West Midlands Passenger Transport Executive, which is also responsible for local rail transport, have attempted to integrate bus and rail services and fares. Rail forms a small but rising proportion of the total passenger journeys, as shown in Table 2.

TABLE 1

WMPTE Bus Passenger Boarding Rate Per Hour (Thousands)

	1979/80	*1980/81*	*1981/82*	*1982/83*	*% Change 1979/80 to 1982/83*
Weekdays					
Morning Peak	147	139	138	127	-14%
0930-1530	106	106	113	106	no change
Evening Peak	148	138	144	132	-11%
1800 onwards	48	41	44	36	-25%
Weekdays	96	91	94	92	-4%
Saturday	83	72	67	64	-23%
Sunday	41	39	33	26	-37%
Whole Week	88	83	83	77	-13%

SOURCE: West Midlands, 1983.

TABLE 2

WMPTE Integrated System Passenger Statistics (millions of passengers)

Passenger Journeys	*1978/79*	*1979/80*	*1980/81*	*1981/82*	*1982/83*
PTE Bus	528.6	528.1	494.7	500.0	457.8
Other Bus	14.1	10.6	9.8	9.1	8.3
Total Bus	542.7	538.7	504.5	509.1	466.1
Local Rail	21.1	23.8	22.0	22.5	20.0
Total					
Bus and Rail	563.8	562.5	526.5	531.6	486.1

SOURCE: West Midlands, Annual Report, 1982-83.

Rail usage by pensioners is likewise small by comparison with bus usage. During the year April 1983 to March 1984 there were 2.75 million rail journeys by pensioners. This represents an increase of 27 percent over the previous year. Prior to the extension of validity of free travel passes, pensioners made up 10 percent of all rail passengers: after the change this proportion rose to 12 percent (Harris, 1984).

Pensioner Travel by Bus and Train in Birmingham

The travel needs of three specific groups of pensioners were studied in a survey undertaken in three suburbs of Birmingham by Ho (1983) who found that:

1. 82 percent of the elderly required transport for nonlocal shopping trips.
2. 49 percent of the elderly required transport for access to a day centre or community centre.
3. 18 percent of the elderly required transport for nonlocal medical trips.
4. 51 percent of the elderly required transport for social visits. These requirements must be seen against what appears to be a very good level of local service provision in the three sample areas surveyed.

Access to Shops

Fifty-seven percent of the elderly could reach the nearest shopping facilities from their home, with less than 10 minutes walk. Yet only 18 percent of the elderly did their main shopping at those local shops. Some 43 percent did not use their most local shops at all. Seventy-eight percent of respondents went to district shopping centres by bus.

Access to Post Offices

The state pension can be obtained by pensioners either by weekly collection from a post office, or through a bank account. The survey sampled found all pensioners collected their pensions weekly from the Post Office. Eighty-seven percent of pensioners had their nearest post office within 15 minutes walk. However, a clear majority of pensioners collected their pension from a district centre, in many cases in combination with a shopping trip.

Access to Community Centers

The average journey length to community centres was only 0.68 miles—less than to shops or medical facilities. This short distance is reflected in the importance of walking as a means of access to such centres:

51 percent	walk
41 percent	bus
4 percent	car
4 percent	train

Car ownership among the sample was low, and only 38 percent stated that they regularly received lifts (generally from relatives). This reflects the Transport and Road Research Laboratory finding that car travel accounts for a significant proportion of the journeys made by the elderly only where they live in a household with a car (Skelton, 1978; Hopkin, 1978).

Strangely, the actual travel by car by pensioners in this sample suggested a much lower level of car usage than perhaps implied by the 38 percent "regularly receiving lifts."

By far the most predominant mode of transport was the bus accounting for 94 percent of travel over .5 mile.

Access to Bus Stops

Pensioners surveyed were asked how long it took them to reach the nearest bus stop. The figures in Table 3 are surprising, but it should be borne in mind that they represent perceptions of time, rather than observation of actual movements. If the elderly feel they have plenty of time, then perhaps that walking time has a low valuation. Nevertheless, when pensioners were questioned about problems with public transport, 24 percent referred to the "long wait" for the bus or train to come.

TABLE 3

Access Time to Nearest Bus Stop

Time	*% Respondents*
1-3 minutes	58%
4-5 minutes	20%
6-10 minutes	20%
11-15 minutes	2%
Total	**100%**

The three sample areas were chosen in areas served by suburban railways, so as to allow for the possibility of choosing rail travel as an alternative to bus. Even so, rail usage was very low. There were fewer complaints about rail travel itself: notably there was an absence of complaints about the vehicle jerkings, a characteristic of buses found unsatisfactory by some respondents. Shared by both bus and railway services was the step-climbing problem cited by 24 percent of respondents. However, the general preference for the bus seems to lie in its better suitability for short inter-suburban journeys.

Policy Implications

Even if many new rapid transit lines were built in an area such as the West Midlands, the level of coverage that could be provided (in terms of average walking distance to stations) would be inferior to that provided by the present bus network.

Methods to avoid access problems for the elderly at stations can, at least, have partial success. Ramps are not an ideal alternative to steps. The provision of lifts at stations is incompatible with the most feasible form of rapid transit—i.e. light rapid transport, where the emphasis is upon simplicity of facilities. The lavish facilities for the elderly and disabled on systems such as the Washington Metro are clearly only possible on the most expensive of systems, normally found in capitals, where prestige is an important element in the decision process. The number of level changes at stations does depend upon the ticket collection arrangements. Traditional, and some recent metro layouts have ticket barriers at an intermediate mezzanine level.

Systems such as the Lyon metro, which have open stations and rely on vehicle inspection of tickets, have no need for a mezzanine level. Thus access to the Lyon metro—built by the cut-and-cover method, often below city centre streets reserved for the exclusive use of pedestrians, can be very direct, and therefore less likely to cause problems for the active elderly.

Another factor concerns the usage of the city centre by the elderly. The evidence suggests that while the elderly are happy to board a bus to reach a shopping centre, it is the nearest district centre, rather than the city centre, that serves as the destination (see average trip length figures below). Typically, district centres can provide the range of facilities most used by the elderly: shops, chemists and community centres or day centres. The city centre of Birmingham, while of course providing a much greater range of shopping faciliites, does not provide the community facilities to be found in district centres. Whilst the major library is to be found in the city centre, the much smaller libraries to be found in district centres—in public branch libraries and in day centres—are possibly of more value to typical pensioners.

It is widely held that there is a social role for very local shopping facilities, of particular value to non-car owners such as the majority of elderly. This study suggests that such local shops, in decline over a long period because of competition from newer forms of retailing, may have their future further undermined in cities where local pensioners can enjoy the benefits of free travel passes.

The usage figures from rapid transit services and suburban railways suggest that rapid transit is most successful in moving people to city centres.

Bus usage is less biased towards city centre destinations, being more used for shorter, inter-suburban journeys.

It seems, therefore, that arguments in favour of development of urban railways, or new rapid transit, are unlikely to be supported in terms of benefits to the elderly.

In the West Midlands, the 1982 / 83 average trip length for all travel, was 4.49 km by bus, and 11.54 km by rail.

Among the elderly the average trip length is slightly shorter. Seventy-five percent of journeys by the elderly, are in 1984, of fewer than 5 stages (1 stage equals approximately 1 km) (Harris, 1984).

One argument sometimes used in favour of rail based public transport investment is that rail-based transport has been demonstrated to be attractive to car-owners (given appropriate levels of congestion, parking charges, etc.) whereas bus public transport is less able to be made attractive to car owners. The survey of pensioners in Birmingham did not enquire as to whether the respondents had at any time in the past, been car drivers.

In future, many more pensioners may be people who have previously been used to the convenience of car travel. The present level of bus usage by pensioners is high, and could be interpreted as showing a degree of enthusiasm for free travel passes, indicated by the relative neglect of the nearest local shopping facilities. For car-owners to adjust their travel expectations, following the loss of their driving licences as a result of growing frailty, may be hard. In the United Kingdom driving licences are valid to the age of 79, and are then renewable on a short term basis, according to one's fitness. For pensioners with car-dependent travel expectations, a free travel pass, whether on bus or rail, or both, may not seem to be enjoyed with quite the same enthusiasm apparently manifest in the travel patterns of today's elderly in the West Midlands.

References

Harris, M.R., Report to the West Midlands Passenger Transport Executive, september 1984.

Ho, Peter S.H., Survey of the travel patterns of three groups of pensioners in Birmingham, 1983.

Hopkin, J.M., Transport and the elderly: requirements, problems and possible solutions. Report SR 419, Transport and Road Research Laboratory, Department of Transportation, Crowthorne, 1978.

Skelton, N.G., Travel patterns of elderly people under a concessionary fare scheme. Report SR 280, Transport and Road Research Laboratory, Department of Transportation, Crowthorne, 1978.

West Midlands Passenger Transport Executive, Annual Report, 1982-83.

Paul Truelove, Lecturer, Department of Civil Engineering and Construction, University of Aston, Birmingham, England, B4 7ET.

MULTIPURPOSE VEHICLES AS A SOLUTION TO THE NEED FOR TRANSPORTATION OF THE ELDERLY AND HANDICAPPED IN SMALL AND ISOLATED COMMUNITIES

Jim Wallace and John C. Rea

Introduction

A key element in bringing the elderly and handicapped into the mainstream of community life is the provision of adequate transportation services. In recent years there have been a number of advances in this field but they have been largely confined to urban areas or heavily populated rural areas. To meet the need for transportation of the elderly and handicapped in lightly populated rural areas the Province of Manitoba introduced a program of assistance to communities designed to comform to the demongraphic characteristics of the Province.

Since the turn of the century there has been a shift to urban living so that some 70 percent of Manitoba's population now lives in a few large urban centres and the remainder on farms or in small communities throughout the province. Outside the City of Winnipeg, which has over half the province's population (578,000), and a few small cities such as Brandon (934,901), Thompson (17,291) and Portage la Prairie (12,555), there are few local public transportation facilities and even local taxis are rare. The existing rural program encompasses thirteen communities with service being provided to contiguous rural municipalities. This program has been largely confined to the southern agricultural area of the province with no services operated in the isolated northern communities.

A challenge that has fascinated the administrators of the province's rural program from its beginning is the question of the minimum size settlement for which a transportation service for the elderly and handicapped can be justified. While it is evident that Manitoba is providing service in communities much smaller than considered feasible in other jurisdictions, there are realistic limitations to what can be done. It has been widely accepted that the establishment of transportation services for the elderly and handicapped is feasible only in those areas where there is a sufficient user population ot justify the purchase and operation of a vehicle and a tax base sufficient to support the service. This would lead one to conclude that service cannot be provided to all small or isolated communities, particularly those in the north.

The introduction of measures designed to keep costs down can help make service viable in small communities. Experience with the existing program in rural communities has shown that where overheads such as accommodation and communications can be shared service can be provided in areas where it would be otherwise unlikely to survive. The use of properly qualified volunter drivers and other staff can also reduce costs significantly. The greatest potential, however, may be found by integrating the service with another program.

In addition to supporting transportation services for the elderly and handicapped in rural areas, the province provides support for local ambulance services through the Emergency Health and Ambulance Services section of the Manitoba Health Services Commission. Of the seventy ambulance services which were operating in 1982, twenty-seven reported less than 100 calls and the lowest usage was seven calls for the year. In addition, there were many other small or isolated communities which had some need for ambulance service although the demand was considered insufficient to justify provision of a dedicated vehicle. Many of the communities with a low incidence of ambulance calls and many of those without ambulance service also have a need for a vehicle capable of transporting the elderly and handicapped, including those in wheelchairs. It is considered that if these needs can be combined and met by a single vehicle a service can probably be justified.

Any suggestion that an ambulance be given other roles immediately causes concern and raises a number of questions:

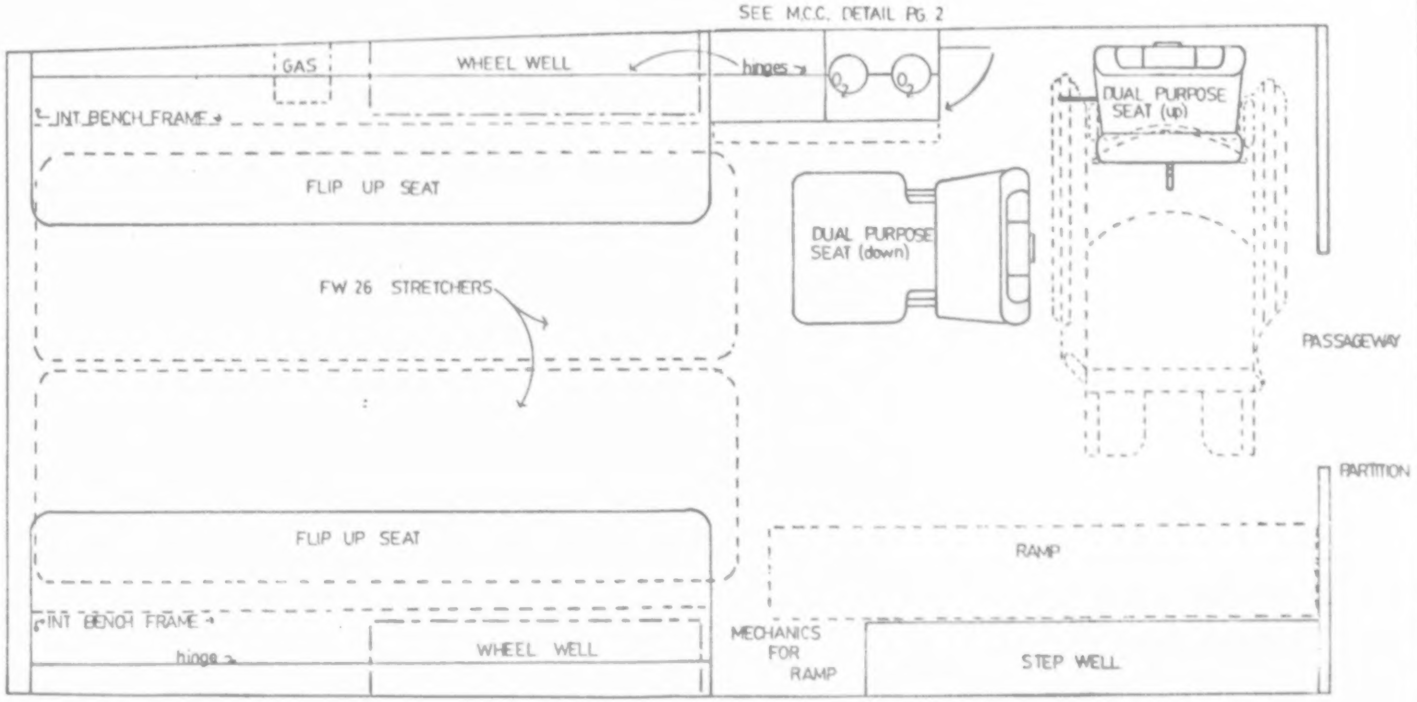
1. Is it feasible to fill both roles with a single vehicle?

2. If the vehicle likely to be available when required for its emergency role?

3. Will the dual roles require modifications to the vehicle which will adversely affect the ability to perform the ambulance function?

4. Will the use of a single vehicle for two services create administrative problems?

The first question is easily answered. There are no technical problems in designing a vehicle that is an ambulance as well as a vehicle for transportation of the elderly and handicapped. The floor plan for such a vehicle designed by Crestline Coach is shown in Figures 1 and

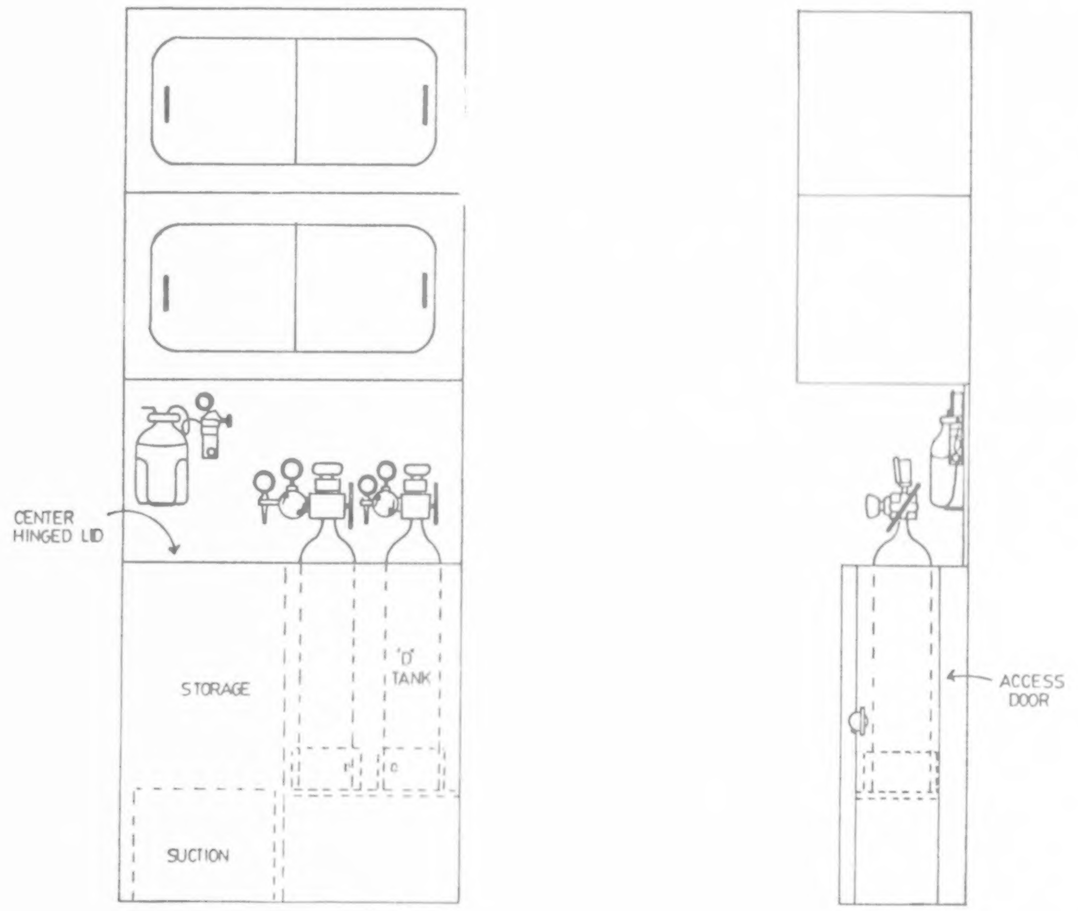


CRESTLINE COACH LTD.
802 57TH STREET EAST • SASKATOON, SASKATCHEWAN • S7K 5Z1 • (306) 665-8585

TITLE: HANDICAB AMBULANCE			
SCALE: 1" = 1'-0"	DRAWN BY: DMM	REVISION NO:	DRAWING NO: HCA-PRO-15
DATE: JUNE 82	APPROVED BY:	PAGE 1 OF 2	

FIGURE 1

Floor Plan of Multipurpose Vehicle



CRESTLINE COACH LTD.
802 57TH STREET EAST • SASKATOON, SASKATCHEWAN, • S7K 5Z1 • (306) 665-8585

TITLE: HANDICAB AMBULANCE			
SCALE: 1 1/2" = 1'-0"	DRAWN BY: DMM	REVISION NO:	DRAWING NO: HCA-PRO-15
DATE: JUNE 82	APPROVED BY:	PAGE 2 OF 2	

FIGURE 2

Life Support Equipment Storage Area

2. The floor plan shown offers the following combinations:

Wheelchair	Main No. 26 Stretcher	Passenger Seating
1	0	7
1	1	4
1	2	1
2	0	3
2	1	0
0	0	8
0	1	5
1	2	2

The two wheelchair positions have dual purpose (flip-up) seats which can be used for ambulatory passengers or an ambulance attendant. The two flip up bench seats in the rear of the vehicle have a capacity for six ambulatory passengers. With these seats folded up there is room for two FW26 stretchers, side by side, in the rear of the vehicle.

A cabinet mounted on the left side by the rear facing dual seat will provide space for two "D" or "E" size oxygen bottles, flowmeters, electric suction unit and first aid and medical supplies. Switches for the operation of suction pump, car heater and other lights and equipment for patient care will be mounted in this area readily accessible to an attendant.

The vehicle itself can be a modified standard commercial van but must be the heaviest available model due to the weight of the raised roof, the lift and additional equipment in addition to passengers and the driver. The design must be such that it is not necessary to raise the stretcher very high to load or unload. Ideally, the height from the ground to the rear floor of the ambulance should not be more than twenty-six inches.

The vehicle should produce a soft, stable ride without undue discomfort to the patients or passengers in the vehicle. In actual practice, however, some ride quality may have to be sacrificed to provide the springing necesary to operate over unimproved roads in remote areas. In any case the right hand springs will have to be adjusted to eliminate sag due to the lift installation.

The two dual purpose seats will be equipped with wheelchair restraints and seat belts. The unit will convert instantly from a wheelchair lock-in device to a seat without requiring any adjustment. The flip-up bench seats at the rear will be equipped with standard seat belts and will have a storage area accessible when the seat is in the raised position.

The design will provide a utilitarian vehicle capable of providing local ambulance service and, at the same time, meeting the needs of elderly and handicapped residents including those in a wheelchair. It thus seems obvious that it is feasible to have one vehicle fill both roles, but the question of availability must still be addressed. In examining the 1982 data it was noted that there are twenty-seven communities that had fewer than 100 calls for their ambulance that year. The highest number of calls was for Hamiota which had 92 calls or an average of one call each 3.97 days. The lowest were Bissett and Baldur with 9 calls or one call each 40.55 days. Since ambulance calls come round the-clock and elderly and handicapped transportation is normally restricted to day and evening hours the likelihood of a conflict in calls is relatively small.

In some cases rural ambulance services make lengthy journeys taking patients to Winnipeg or other major centres. In these cases the local ambulance may be gone for a considerable time and the community must either go without ambulance service or obtain coverage from a nearby community. It is considered that it would not be reasonable to try to operate a combined service in communities where the ambulance/handivan might be called away for lengthy periods on short notice. The multipurpose vehicle design incorporates minimum life sustaining equipment and is not the optimum vehicle for long distance patient transportation It should be noted, however, that in those locations where there is no backup ambulance service available from neighbouring communities a dual purpose vehicle would provide an ideal backup.

There is an extensive administrative organization for the operation of rural ambulance services with delivery of the service being in the hands of local government. The Manitoba Health Services Commission has introduced a communications system and driver training standards and has developed a province-wide network based largely on volunteer drivers. The program for the transportation of the elderly and handicapped is administered by the Department of Highways and Transportation but it too places program delivery in the hands of local government. There is constant liaison and cooperation between the two departments and at the local level the programs are often delivered by the same individuals. From experience it would appear that there should be no problem introducing a multipurpose vehicle at the local level.

Having concluded that it is feasible to fill both roles with a single vehicle it is necessary to establish criteria for the selection of communities where such service is feasible, then develop operating criteria to minimize the risk of interference with the primary purpose of the vehicle.

In establishing criteria for communities where suoh service is feasible we can divide them into two categories:

1. Those which now have ambulance service but no elderly and handicapped transportation service.

2. Those having neither ambulance nor elderly and handicapped transportation service.

For those communities with ambulance service but no elderly and handicapped transportation service the following basic criteria are suggested:

1. The community ambulance should not be required for long distance patient transportation thus making the use of a minimal ambulance acceptable.

2. The demand for ambulance service should be sufficiently low to provide an acceptable risk that the ambulance will not be immediately available.

3. The radius of operation should be such that when called by radio the driver could deliver his elderly or handicappe passenger to a place where they can be adequately cared for and then respond to the ambulance call.

After due consideration it was decided that use of a dual purpose vehicle in communities having 50 or less ambulance calls per year (approximately one per week) would be an acceptable risk. Other communities which do not meet these criteria but have a demand for elderly and handicapped transportation may consider introduction of a dual purpose vehicle as a second vehicle to provide backup for the primary ambulance as well as handivan service.

The most exciting area and that with the greatest potential is in those communities having neither ambulance service nor transportation for the elderly and handicapped. These small and remote communities cannot support either ambulance or handivan service but could, possible, support a combination.

The criteria for establishment of service in such cases could include:

1. Existence of a hospital, nursing station or care facility on which service can be based.

2. An established need for wheelchair and ambulatory transportation for the elderly and handicapped.

3. A restricted radius of operation with no long highway trips.

This would allow the provision of local transportation for the elderly and handicapped in very small communities, where it would otherwise be impossible to consider such service. As an example, there could be a multipurpose vehicle in an isolated northern village so remote that it is not even connected to the provincial highway system.

The concept of emergency ambulance service often dictates that there will be very low vehicle utilization. The concept of the multipurpose vehicle converts this underutilized capacity into transportation service for the elderly and handicapped. Manitoba has pioneered innovations in bringing elderly and handicapped transportation services to rural areas. The multipurpose vehicle concept can provide the solution to the problem of extending such service to small and isolated communities.

Jim Wallace, Manager of Transportation Subagreements and John Rea, Director, Transportation Policy, Programs and Research Division of the Manitoba Department of Highways and Transportation, Winnipeg, Manitoba, Canada R36321

A HISTORY OF THE SECTION 504 REGULATIONS

Erskine S. Walther, William Crown, Lalita Sen, and Harold G. Willis

Background

The intent of the present discussion is to review the major points in the legislative development of Section 504 of the Rehabilitation Act of 1973 and the subsequent efforts at implementation of that Section in the fields of public and specialized transportation.

The legislative history of efforts to improve mobility of elderly and handicapped citizens is of recent record. The 1971 White House Conference on Aging and a series of preceding and succeeding events addressing the mobility problems of the elderly and the handicapped provided the necessary stimulus to spur the United States Congress to consider passage of a series of amendments and statutes which had the intent of improving transportation services for the elderly and the handicapped. The major Congressional actions were passage of Section 504 of the Rehabilitation Act of 1973; elaboration of Section 16 of the Urban Mass Transportarion Act of 1964 as amended and Section 165 of the Federal-Aid Highway Act of 1973 as amended. For the present purposes the legislation of primary interest is Section 504 of the Rehabilitation Act of 1973.

Section 504 States:

> No otherwise qualified handicapped individual in the United States shall, solely for the reason of his handicap, be excluded from participation in, be denied the benefits of, or be subjected to discrimination under any program or activity receiving federal financial assistance.

While the section is specifically targeted to the handicapped, in actuality the impact of the section is closely tied to transportation of the elderly as well.

Given the broad support for this legislation and the skillful lobbying efforts of representatives of the handicapped community, the legislation initially did not produce a major controversy. The debate prior to passage gave little attention to the cost of implementation or to the long term implications of the statute. Indeed, the early legislative history is relatively brief and offers no indication of subsequent efforts associated with implementation of this measure.

Implementation Steps

Table 1 displays a brief chronology of the major activities concerning implementation of Section 504 guidelines. As can be observed, several activities occured at the same time in apparent disregard of each other.

TABLE 1

Chronology of Section 504 Implementation Activities

1973	Passage of Section 504 of Rehabilitation Act of 1973.
April 1976	DOT issues guidelines for Biaggi amendments (not directly 504 related); first use of 5% guideline and special efforts requirement.
April 28, 1976	Executive Order 11914 directs HEW to establish government wide Section 504 guidelines.
February 1977	First accessible bus service (San Diego, CA)
April 1977	Handicapped Sit-in at HEW offices
May 4, 1977	Interim HEW government wide regulations regarding Section 504
May 19, 1977	Transbus regulations (UMTA)
January 13, 1978	"Final" governmentwide Section 504 Guidelines issued by HEW
June 8, 1978	DOT issues proposed rule making on Section 504 regulations
January 1979	First bid request for Transbus
May 31, 1979	"Final" DOT Section 504 Rules—50% accessibility with wheelchair lifts or 2% rule for interim service
June 29, 1979	APTA sues DOT
August 1979	Transbus delayed
February 1980	APTA receives adverse ruling in lower courts
May 26, 1981	Appellate court rules DOT exceeded its authority under Section 504
July 20, 1981	Interim Final Rules published by UMTA; 3.5% rule established
December 1982	Section 317(c) of the Surface Transportation Assistance Act mandates the issuance of Section 504 rules
September 8, 1983	Proposed Final Regulations published by UMTA
January 1984	Review of comments and development of "final" rules begins

Recapitulation of Steps Taken on Section 504

Before reviewing the implementation efforts directly flowing from passage of Section 504, reference[1] to the guidelines, on the so-called Biaggi amendment, is in order. The Biaggi amendment (named after a major Congressional supporter) to the Urban Mass Transportation Act of 1964 (Section 16(a)) as amended required that special efforts to serve the transportation needs of the elderly and the handicapped populations be made by recipients of federal transit assistance funds.

Following public meetings during November 1974, the Department of Transportation (DOT) issued proposed rules for implementation of Section 16(a) of the Urban Mass Transportation Act of 1964, as amended, and Section 165(b) of the Federal-Aid Highway Act of 1973, as amended. The proposed rules, published on February 26, 1975, underwent further modification to become the final rules of April 1976. While citing Section 504 as part of the Department's authority to issue the proposed rules (1975), the "Codification of Requirements" cite only Section 16(a) and Section 165(b). On October 20, 1976 the Department published its proposed policy on Paratransit Services which said that paratransit services should be encouraged but, again, made no reference to Section 504. Thus, for the present purposes, these proposed and finalized policies and rules are not considered to be part of the Department's 504 efforts per se, but part of the Section 16(a) and Section 165(b) special efforts activities

These guidelines permitted several alternatives, the most widely accepted was the expenditure of an amount equal to 5 percent of a recipient's UMTA Section 5 funds on special effort activities. It was not required that actual Section 5 funds be expended, just that an amount equal to 5 percent of those funds be expended regardless of the source of the actual dollars utilized.

Alternately, a local paratransit system could make 50 percent of its bus fleet accessible by means of wheelchair lifts or a system could provide ten trips per week to the semi-ambulatory or to the wheelchair bound.[2] Of these options, the 5 percent rule was the most straightforward and the most widely accepted. Even though rhis was not part of the Department's Section 504 effort per se, these guidelines became interwoven with subsequent 504 regulations.

With respect to regulations directly flowing from Section 504, Executive Order 11914, April 28, 1976, instructed the Secretary of Health, Education and Welfare to issue government wide regulations for implementing Section 504. However, no meaningful action occurred until April of 1977 when members of the handicapped community staged a sit-in at the then Department of Health, Education and Welfare's (HEW)[3] headquarters in Washington, D.C., as well as at several regional offices. The demonstrations were prompted by HEW's inaction regarding promulgation of regulations for the implementation of the Section 504 requirements during the Nixon and Ford administrations and a disagreement over the need for a Carter administration review of existing draft regulations. After discussions with the demonstrators, an agreement was reached and HEW issued interim regulations on May 4, 1977.

The HEW regulations set forth government wide policy with respect to implementing Section 504. Each department and agency in the government was then required to develop regulations specific to its programs which were congruent with the HEW regulations. This discussion focuses upon the regulations issued by the DOT and, in particular, those impacting bus and paratransit services.

In a related matter, the first accessible buses in the United states were placed into service in San Diego, California, in February 1977. St. Louis, Missouri followed with accessible buses in August 1977. These early efforts at providing handicapped mobility by means of accessible fixed route transit have importance because they provided the first indication of the costs and utilization levels associated with this approach to fulfilling the intent of section 504. These early experiences revealed high costs and relatively low utilization rates, two factors which continue to be major considerations in the implementation of Section 504.

In May of 1977, UMTA introduced a regulation which rended to confuse the history of Section 504. This was the Transbus regulatioon. While not a response to Section 504 and while not requiring full accessibility[4] (wheelchair accessibility was optional, for example), the Tranbus efort is often viewed, incorrectly, as part of the Department of Transportation's 504 response.[5]

Meanwhile, the Department of Health, Education and Welfare issued its Section 504 guidelines in January 1978.

---

[1] Rosenbloom, Sandra. "Federal Policies to Increase the Mobility or the Elderly and the Handicapped," Journal of the American Planning Association, 1982, Vol. 48, No. 3, p. 338.

[2] Ibid.

[3] Now the Department of Health and Human Services (HHS). When HEW was dissolved, responsibility for government wide guidelines for Section 504 was transferred to the Department of Justice (DOJ) (Executive Order 12250).

[4] 49 CFR Part 609.15, amended.

[5] While the Section 504 regulations continued to be promulgated, the Transbus saga also went on. In January 1979, a consortium composed of Los Angeles, Miami and Philadelphia requested bids on 530 Transbuses. No bids were received from domestic manufacturers. In light of this reality, the Department of Transportation temporarily delayed the Transbus regulations on August 3, 1979. The delay became permanent, and Transbus became a dead issue for all practical purposes.

These guidelines took the position "that any federally-funded program or activity, when viewed in its entirety, must be readily accessible to, and usable by, handicapped persons"[6] This established the concept of program accessibility which continues to be a main focus of the Section 504 requirements. On June 8, 1978, the Department of Transportation issued a call for proposed rule making on Section 504. However, almost one year elasped before the final rules were published.

The Department of Transportation issued its "final" 504 rules on May 31, 1979. For fixed route transit, these regulations required:

- for purchases after July 2, 1979, all public transit buses must be accessible and include wheelchair accessibility.
- within three years, fixed route transit must have program accessibility and 50 percent of the peak hour fleet must be accessible within ten years.
- if the above can not be accomplished within three years, then some form of interim accessible service must be provided and that the interim service must have certain specified comparabilities to the fixed route service. If this approach is adopted, then at least 2 percent of the system's Section 5 funds must be spent on the interim service.[7]

Shortly after the issuance of the May 1979 regulations, the American Public Transit Association (APTA) filed suit to prevent the enforcement of the regulations. In particular, APTA objected to the wheelchair accessibility requirement because of the high costs associated with that requirement. In February 1980, the federal court ruled against APTA. However, upon appeal, APTA obtained a ruling,[8] on May 26, 1981, that the Department of Transportation had exceeded its authority in requiring wheelchair lifts.

The Court based its ruling primarly upon a U.S. Supreme Court ruling (Southeastern Community College v. Davis, 442 U.S. 397 (1979)) which held that Section 504 does not require modifications which fundamentally alters the nature of a program. In the same case, the Supreme Court held that changes which result in "undue financial and administrative burdens" are not required by Section 504. The U.S. Court of Appeals did not void the regulations in question (Subpart E of 49 CFR Part 27), but it did remand the matter to the Secretary of Transportation to determine whether or not statutory authority other than Section 504 existed which would support the questioned requirements.

While the suit was in process the situation continued to be debated within the Congress and the transit community with growing support for local option; i.e., the ability of local areas to determine the methods by which transportation for the handicapped would be provided (fixed route accessible, accessible paratransit or some conbination).

During the 1980-1981 Congressional session support for the local option approach found its way into amendments to the 1980 Surface Assistance Transportation Act. However, the session ended before enactment of the legislation took place.

The new federal administration which arrived following the 1980 presidential election established a Presidential Task Force on Regulatory Relief. This Task Force gave priority review status to the U.S. DOT's 1979 rules. In response to this review, the Department took the position that the handicapped must be provided with transportation services by recipients of federal assistance but that the local communities have the "major responsibility" for determining the form of the transportation services provided.

After the Department established the above policy and after the receipt of the Court of Appeals' ruling, the Department issued "interim final" rules in July 1981. The interim final rules removed those sections from the 1979 final rules which had been the subject of the court action and reinstated the special efforts requirement first introduced in 1976 in response to Section 16(a) of the Urban Mass Transportation Act and Section 165(b) of the Federal-Aid Highway Act. The 1981 rules modified the 1976 requirement of expending 5 percent of a recipient's Section 5 funds on special efforts. These 1981 rules imposed a financial level of effort criteria equivalent to 3.5 percent (an amount judged equivalent in 1981 to 5 percent in 1977, the first full fiscal year of the 1976 rules) of the recipient's Section 5 funds. The recipient may count the expenditures of other operators (e.g., operating expenditures by Section 16(b)(2) recipients and human service providers) toward the 3.5 percent amount whenb these special services meet certain requirements including accessibility.

The circumstances remained unaltered until the passage of Section 317(c) of the Surface Transportation Assistance Act in late 1982. This section required the Department of Transportation to issue permanent regulations dealing with handicapped persons' access to transit buses (rail services were not included). In accord wirh this requirement, UMTA issued proposed final regulations on September 8, 1983. These proposed requirements, which have not been finalized as of this writing, permit the local recipients of UMTA funding to fulfill the Section 504 requirements by a 50 percent accessible bus fleet, by provision of specialized transportation services, or by some combination.

---

[6] Paratransit Services for the Transportation Handicapped, Urban Mass Transportation Administration, U.S. Department of Transportation, Washington, D.C., Final Report, April 1982, p. 58.

[7] Federal Register, Vol. 44, No. 106, Thursday, May 31, 1979, pp. 31455-31457 and 31459-31463.

[8] American Public Transit Association v. Lewis, 556 F.2d 1271 (D.C.Cir., 1981).

The Currently Proposed Final Regulations

The currently proposed final regulations grew out of a concern by members of the U.S. Senate that the interim final rules were permitting widespread deficiencies in paratransit services for the elderly and the handicapped. The deficiencies cited included such items as trip priorities, advance reservation requirements, waiting lists for service, delays in service delivery and restricted service areas, to note but a few of the major topics of concern.

The Congress held the view that these deficiencies arose for the interim final rules of 1981. Thus, Section 317(c) of the Surface Transportation Assistance Act of 1982:

> directs the Department to change its approach to implementing Section 504 both substantively and procedurally. Substantively, the statute requires that DOT's new regulation include "minimum criteria for the provision of transportation services" to handicapped persons. Procedurally, the statute calls for explicit regulatory provisions concerning the participation of handicapped persons in the establishment of transportation services for their use and for monitoring by the Department of recipients' compliance with section 504 requirements.[9]

In line with this directive, the Department of Transportation issued the aforementioned proposed "final rules" on September 8, 1983. As of this writing, these rules are still in the Department's review process and are not expected to be finalized until sometime in 1985.

The proposed rules preserve the local option concept in that eligibility may be established by making fifty percent of a recipient's peak and non-peak fixed route bus fleet accessible to "handicapped and elderly persons"; or by providing some mix of accessible fixed route service and paratransit services.[10]

If paratransit (also termed special services in the proposed rules) is provided, then it must meet certain criteria specified in the proposed rules. These criteria[11] can be summarized as follows:

- service area must be the same as that of the recipient's general public service;
- the paratransit service must be available on the same days and for the same hours as the recipient's general public service;
- the cost of a trip to the user must be comparable to that charged for a similar trip made by the general public;
- trip priorities or trip purpose restrictions can not be imposed;
- wait time for special service must be reasonable, and,
- no waiting lists can be maintained, i.e., service must be available for all eligible persons.

These criteria are viewed as minimum standards to be met by all recipients of federal transit assistance funds. However, in meeting these criteria no recipient will be required to expend funds, in any fiscal year, according to one of two alternatives:

> Alternative 1—7.1 percent of the average annual amount of Federal financial assistance for mass transportation it expects to receive over the current fiscal year and has received over the two previous fiscal years
>
> Alternative 2—3.0 percent of the average of the recipient's operating budgets for the current fiscal year and the previous two fiscal years.[12]

The proposed rules continue by specifying allowable costs which may be counted towards the above financial effort ceilings.

Finally, the proposal specifies various procedural requirements which recipients must follow. These requirements cover the recipient from the first step of obtaining public comment upon the recipient's proposed program for fulfilling these proposed 504 rules to the final certification of the program by the UMTA Administrator.[13]

Concluding Comments

The history of federal guidelines for the transportation of the elderly and the handicapped under Section 504 seem to have come full circle. Original federal directives embraced the concept of special efforts with local areas making the service delivery decisions. The proposed regulations again advance the concept of local option with a new form of special efforts. The proposed regulations go beyond the starting point of this cycle by detailing specific service provision criteria which must be fulfilled.

During the intervening years, the views and positions of the various communities of interest participating in the Section 504 debate have undergone various degrees of modification. The experiences of numerous transit systems and specialized service providers have provided cost, reliability and utilization data which have helped to define the real world impacts of the various approaches to ensuring the mobility of elderly and handicapped citizens.

---

[9] Federal Register, vol. 48, No. 175, September 8, 1983, p. 40685.

[10] Ibid., p. 40693.

[11] Ibid

[12] Ibid

[13] Ibid. pp. 40693-40694.

Even so, the major points of view remain, largely, the same as in the early 1970's: mainlining vs. specialized service. Representatives of the handicapped communities argued forcefully for mainlining (accessible fixed route transit) more as a force for social change than as an efficient means of transportation. Supporters of specialized services approached the issue from the perspectives of quality and efficency.

Over the past decade, the need for mainlining for social goals has declined as handicapped citizens have become more accepted in mainstream America, but the support for mainlining in public transportation does not seem to have diminished significantly among representatives of the handicapped organizations. The experiences of numerous transit systems seem to indicate that accessible fixed route transit meets the needs of only a minority of handicapped citizens, while specialized services can provide adequate transportation service for a wide range of elderly and handicapped individuals. It would appear that the time is appropriate for the formulationof a consensus view which supports a combination of accessible fixed route service for those segments of the handicapped community for which this is a valuable service and specialized transit for those whose needs are not met by accessible fixed route services. The emphasis is federal policy on the local option arena may be a recognition of this need for local consensus formulation.

Whether or not such is the case, it is clear that the forum of interest is shifting from that of federal regulations to that of local decision making. In an era of declining or static financial resources coupled with increasing needs, the choices faced by local transportation providers and local political decision makers are likely to be ones of great difficulty and considerable delicacy.

Erskine S. Walther, Transportation Institute, North Carolina A&T State University, Greensboro, N.C. 27411; William Crown, Florence Heller Graduate School, Brandeis University, Waltham, MA 02254; Lalita Sen, Center for Transportation Training and Research, Texas Southern University, Houston, TX 77004; Harold G. Willis, Transportation Institute, North Carolina A&T State University, Greensboro, N.C. 27411.

EFFECTIVE TAXICAB TRANSPORTATION FOR THE DISABLED

Michel Wilson

Introduction

In January 1982, Transport Adapte du Quebec Metro Inc. (TAQM), a specialized transport service and a subsidiary of the Quebec City Transit Commission, introduced the use of taxicabs for transportation of disabled persons throughout its area. This new service brought drastic changes in the operation of the system; the results are most positive for the corporation, its users and the taxicab industry. A majority of the corporation's clientele, such as the blind, mentally deficient and the handicapped in manually-operated wheelchairs, are now transported by cab. In addition, adapted vehicles with ramps are used almost exclusively to transport users of motorized wheelchairs.

In December 1983, a total of 860 persons were admitted to the service. Out of the total trips made in 1983, 37 percent were by ambulatory disabled; 56 percent were by wheelchairbound and 7 percent represented attendants. The trip destinations were as follows: 32.3 percent for work, 33.6 percent for leisure, 25.5 percent for services and 8.6 percent for study; 62 percent of the users were transported by taxis and 38 percent by modified vans.

The integration of taxicabs with our pre-existing resources was easily accomplished. We have targeted the taxi cooperatives of the Quebec City area; first because they represent the greater number of cars in their district; secondly, they are structured with a board of directors, a supervisory committee and a code of ethics. Thirdly, the drivers, as the owners of their cars, have committed themselves to respecting the rules of their cooperative and therefore do not tend to be unionized.

Presently, we are dealing with four different cooperatives; each of them serving its own sector of the Quebec City area.

Reservation Procedure

The reservation procedure did not change for the taxi user. It is rather in the internal operation of TAQM that some modifications were undertaken.

The reservation is taken on the telephone by an operator who checks with the central file to find out which mode of transportation was assigned to the user when he or she was admitted. Having established, for instance, that the trip can be made by cab, the operator will then forward the request to the dispatcher on duty. According to the address and hour requested, the dispatcher will check the feasibility of combining more than one trip request for use of the same taxi. This means that one car may carry up to three or four passengers with different addresses, all on the same trip. On the other hand, considering the geographical location of addresses to be served, the dispatcher could require more than one cab for a group of persons, if it is previously established that the total ride cost will be lower by using more than one car.

The dispatcher will then call the taxi cooperative covering the territory from which the trip request originated. The taxi dispatch will transmit the call to the cab drivers, informing them of the number of persons to be carried, attendants to be accepted or wheelchairs transported.

For regular and repeated trips, the taxi dispatcher is supplied in advance with the list of users, addresses to serve and the pick up time requested. All orders given to the taxi dispatch bear an order number which appears on the bi-monthly billing. This billing also includes all the signed charge slips presented by the drivers.

Advantages and Inconveniences of the System

In looking at the advantages and inconveniences which characterize ths new collaboration with the taxicab industry, the advantages are cited first:

1. We have increased our trip resources over the past two and a half years without having to buy additional adapted vehicles. Therefore, investment on that account is considerably reduced. As of August 1984, we have a fleet of six modified vans in comparison to the eleven in 1981.

2. Trip rejections (10 percent in 1981) were brought down to almost none for 1982 and 1983. This statistic could change in the future.

3. Transportation cost per passenger is considerably reduced.

4. There are less changes of hours imposed on the user.

5. The passenger's average travel time is considerably shortened, to the satisfaction of the users.

6. Taxis are an ideal mode to integrate with the typical transportation system.

7. Users can travel more easily and flexibly from one place to another.

8. Due to the increased number of vehicles available, the dispatchers experience a greater flexibility in assigning trips.

9. The twenty-four hours reservation requirement has been reduced to eight hours.

10. For the last three years, the number of employees in our corporation has not increased. The thirty-four employees in 1981 have by August 1984 been reduced to twenty-three. This suggests that the existing staff can absorb some increased demand without affecting service.

11. Finally, one cannot ignore the new source of income brought to the taxi industry which now transports two-thirds of our clientele.

Turning to the inconveniences experienced by the service users suggests the following negatives:

1. Premature wear or occasional damages to wheelchairs of users due to multiple manipulations.

2. Wheelchairs are often cold, wet or both, depending on the weather. This is related to the fact that with certain types of cars, the trunk lid cannot be closed properly when carrying one or two wheelchairs.

3. The physical effort required to transfer oneself from the wheelchair to the car and vice versa is substantial.

TAQM, for its part, after three years of experience, has noticed the following problems:

1. The fleet of taxis in our area is made up increasingly of small cars. This increases the difficulty of carrying more than one passenger, especially when wheelchairs are involved.

2. On peak hours or in bad weather it is more difficult to obtain taxis to satisfy the scheduled users.

3. Passengers experience delays frequently due to the fact that cab drivers can choose their trips.

4. Since transportation is easily available to the disabled, some users have contributed to the increase of "no-shows." A no-show is a transportation demand for which the user is not present as scheduled at a given address. To keep that problem to a minimum, the user is advised by letter that if the situation is a recurring one, a more stringent reservation procedure would be applied in his case.

Despite these problems, the advantages outweigh the negatives and inconveniences. As a consequence, the corporation has renewed agreements with all four local cooperatives for the next two years.

Main Terms of the Agreement

- TAQM is not liable for any trip which has not been expressly requested and confirmed with an order number.
- TAQM is not responsible for any expenses occured when a user is not present at a given address (no-show).
- The cooperative must inform TAQM if an unexpected or alternate user or attendant shows up for the trip at a given address.
- The cab driver must provide proper assistance to the user to and from the car.
- The meter is to be started only when the user is on board and must be stopped at the arrival point.
- The cooperative must show proof to TAQM that a minimum liability insurance of at least $500,000 has been contracted to cover the disabled person when outside the car.
- TAQM is not liable for any additional charge covering handling of luggage or parcels.
- TAQM pays a 5 percent administrative charge on the total billing for credit support.
- The cooperative supplies a list of prices for standard trips agreed upon by both parties.
- TAQM can require that a cab driver who has not complied with the basic obligations of the agreement be removed from the list of approved drivers.

Finally, a few statistics that will confirm the positive results of the last three years.

Statistics

- Two-thirds of the users have been transported by taxis and one-third used the modified vehicles of the corporation.
- The average trip distance represented 10 kilometers; one trip can include one or more addresses to be served.
- The average distance covered by a single user was 6.3 kilometers.
- The average number of passengers per ride is 1.7 for the whole territory. This statistic may vary according to each cooperative's area.

Note that use of a passenger/ride ratio, rather than a passenger/hour ratio, is because of the difficulty in calculating the actual time that the taxi was in direct service for TAQM.

To summarize, in 1981 for a total operating cost of $927,341, 51,544 people were transported for an average cost of $18 per person. At that time, only adapted vehicles were used. The rejection rate represented about 10 percent of the total demand. In 1982, some 65,982 persons were transported (28 percent more than in 1981). Total spending for that year represented $1,157,385. The average cost per person transported in an adapted vehicle was $22.14 compared to $15.18 by taxis. Combined average cost per person was $17.54 in 1982. In 1983, 79,714 persons (21 percent more than in 1982) were transported for a total operating cost of $1,137,824.

Combined average cost per passenger was $14.27. The average cost per person carried in an adapted vehicle was $17.91 while the taxi cost was $12.22.

For 1984, we anticipate ending the year with a 15 percent increase in the number of persons transported. The approved budget is $1,225,298.

It can be said that giant steps have been made to improve public transportation for the disabled in the Quebec City area. The use of taxis proved to be a new and flexible mode of transportation which has permitted the demand for specialized transport to be met more adequately than ever. The users' satisfaction is one's proof of this claim. The taxicab is now an integrated and important part of the public transportation system for the disabled.

Michel Wilson, Administrative Director, Transporte Adapte du Quebec Metro Inc., Quebec City, Quebec, Canada.

TRANSIT FOR THE TRANSPORTATION DISADVANTAGED IN MISSISSIPPI

J. Fred Wise and J. William Rush

Introduction

It has been said that transportation is the life blood of an area's economy. Also of considerable importance is the fact that transit for the transportation disadvantaged is an essential element of a more productive, healthier, and happier life for this important group of our citizenry.

Mississippi has an abundance of transportation disadvantaged and limited financial resources for adequately meeting their needs. The area is a poor, sparsely populated rural state with a total of about 2.5 million people. According to the 1980 U.S. Census, Mississippi leads the nation in poverty with 24 percent of the State's population in this category compared to 12.5 percent nationally. Mississippi ranks 49th in median income with $14,992 compared to the national average of $19,908. The State's total operating budget for Fiscal Year 1985 (July 1, 1984-June 30, 1985) was approximately 1.36 billion dollars. Approximately 70 percent of the operating revenues is derived from state sales and income tax. The task of meeting the rather substantial disadvantaged transit needs under existing and anticipated funding constraints is an overwhelming one.

The purpose of this paper is to document the approach taken by the Mississippi Department of Energy and Transportation and more importantly, the efforts of the local transit providers to make the most of limited funds through improved coordination, and effective and efficient use of local resources.

Problems Uncovered

The Surface Transportation Assistance Act of 1978 amended the Urban Mass Transportation Act of 1964 to include "Section 18—Public Transportation for Non-Urbanized Areas". The Section 18 Program was intended by the U.S. Congress to improve and augment general public transportation in rural area and cities with fewer than 50,000 people.

In 1980 the Governor of Mississippi designated the newly formed Mississippi Department of Energy and Transportation to administer the Section 18 Rural Public Transportation Program. A myriad of problems existed regarding the provision of transit services to the transportation disadvantaged of rural Mississippi. To date not all of the problems have been solved and service is not yet at an optimum level. However, it is believed that most of the problems have been identified, many have been solved, and the remaining problems are being addressed. More public transit is available in Mississippi than ever before. On the other hand, unfortunately there are more transportation disadvantaged in the state than ever before.

The first major problem observed with rural transit in Mississippi was the extent of deficiencies in existing services. Due to limited income, age and physical disability, the size of the transportation disadvantaged population in the state was substantial.

A number of federal programs had been developed over the years to address the needs of the transportation disadvantaged, but they were neither developed nor administered in a coordinated manner to collectively utilize available resources in maximizing available transit services. The Urban Mass Transit Administration's Section 16(b) (2) was designed to meet the special needs of older people and the handicapped by providing funds to acquire vehicles and other equipment. The Social Security Act, Title XX Program; Title III of the Older Americans Act, and Community Services Act of 1974 also made funds available to assist in the provision of transportation services for eligible segments of the transportation disadvantaged population. The services provided through the use of funds from the previously mentioned programs were of a categorical nature. These transportation funds have, however, been a vital part of providing essential service, mainly to elderly and handicapped and low income persons. In some cases, the transportation is needed simply to make other program benefits accessible, while in other cases the transportation service improves the individual's quality of life by providing access to employment, shopping, and recreation. Due mainly to restrictive federal regulations and different organizational goals and policies, there has been a proliferation of transit providers throughout the state.

The specialized network in Mississippi consisted of 800 vehicles providing services under the direction of 150 separate organizations. Due to the exclusionary nature of much of the service and limited coordination among providers, the cost per unit of service was high. To further complicate the situation, many of the agencies providing service experienced a reduction in funding or inadequate increases for increased cost of providing services. These circumstances have led to poor vehicle utilization and limited transportation service. Additional problems associated with the fragmented, poorly funded, exclusionary service approach to transit have included: excessive administrative costs; high maintenance cost with essentially no preventative maintenance; limited accountability; poor vehicle design, i.e. not very accessible to elderly and handicapped due to narrow isles, limited room between seats, high steps, limited capacity and limited useful life; inconsistent and frequently inadequate levels of safety, i.e. limited or no driver training, emergency medical training, defensive driving, commercial licensing or transit driver certification; and poor public image.

Funding for most of the services has historically been totally federal or a combination of federal and local dollars. Many of the previously mentioned problems are perpetrated by funding source restrictions and the fact that transportation is not the principal function of the provider organizations. Limited local level flexibiity exists for the use of funds. When opportunities have been identified to improve coordination or to consolidate the provision of service turfism becomes a key issue.

It has been well documented that most social service agencies will resist the consolidation, or even the coordinated dispatching of the vehicles which serve their clients. The plea is that they cannot carry out their programs effectively unless the directly control client transportation service. Also, claims are made that coordination would cause a compromise of service to their clients. The question is why a professional, social or medical worker wants to be a transit operator, and why the taxpayer should support these individual vehicle fleets if it can be shown that consolidation or coordination can produce better service at the same or less cost.

Reluctance at the state level to pooling of financial resources is frequently attributed to another agency's incapability of being compassionate enough or interested enough in an agency's clients to assume transportation responsibilities satisfactorily. This is often the only reason provided publicly. Under the institutional arrangement for provision of transit services, in recent years, there has been a limited and totally inadequate level of monitoring activity based on performance or service standards and various indicators of efficiency and effectiveness. The result has been a tremendous variation from one area to another in terms of level of service and cost/unit service It is not difficult under the circumstances to see why transportation for the disadvantaged is frequently perceived as a poorly conceived inefficient government giveaway program rather than an essential public service in some ways similar to parks, libraries, and fire-police protection.

In addition to inadequate monitoring, the transit services are poorly planned, if planned at all. Frequently the level of participation in the service planning process has been limited for user groups, local government officials, members of the general public and other transit providers. Without the necessary broad based participation in service planning, needs cannot be adequately determined, existing service levels cannot be determined, and the best alternatives cannot be designed and evaluated.

Once services are provided, the availability of those services appears to be a well kept secret due to limited publicity. Other problems include: a limited level of technical assistance available to the providers from the state or federal level; inadequate insurance coverage and excessive rates. Additionally, there is an absence of any kind of forum for the variety of transportation providers to assemble, identify, and address issues of common interest and to collectively recommend policies, programs, and solutions to problems to appropriate federal and state legislative groups and agencies in addition to simply sharing experiences, ideas, and improving coordination.

Solutions Proposed

Many of the previously mentioned problems were identified during the course of preparing a statewide transit plan for rural public transit administration. The planning effort in itself was a first major step toward improving transit in Mississippi. The study was conducted by the state's ten planning and development districts following guidelines established by the state's Department of Energy and Transportation to ensure consistency. For the first time the state knew what types of services were being provided at what cost, the level of transit demand, deficiencies in service, and alternative means of addressing those needs that were not being met. The planning process required a series of county level public meetings. A sincere and successful effort was made to include transit users, potential transit users, transportation disadvantaged, elected officials, transit providers, and representatives of other segments of each area's population. The plan continues to serve as an flexible, as opposed to rigid, guide for implementing coordinated transit throughout the state.

Meeting unmet trip demands of the transportation disadvantaged will require a combination of more efficient and effective utilization of existing resources and new resources as well. The optimum means of improving coordination to enhance efficiency is often consolidation of transit service responsibility. Pooling the financial resources increases the potential for flexibility in providing expanded nonexclusionary services in a comprehensive manner without duplicate administrative costs. Social service agencies who entered the transportation business out of necessity to get their clients to service centers, are urged to purchase those services from a consolidated provider of transportation services. The social service agency is then free to emphasize the provision of its principle services. It is readily acknowledged that a consolidated area provider may be a human service agency with responsibilities other than transportation. Consolidation of transit service responsibility will, more or less, often enable the agency to justify, on an economic basis, the bulk purchase and storage of fuel, and the hiring of mechanics for preventative maintenance and repairs which may increase the safety and useful life of vehicles.

The Section 18 Rural Public Transit Program served as a catalyst for consolidating services where consolidation is determined to be beneficial. The state plan also ensures an increase in state level transit activity which creates an opportunity for expanded transit technical assistance of providers and potential providers. The State's Department of Energy and Transportation employs a Transit Manager and three transit specialists who work with transit providers to maximize service to the public and minimize the cost per unit of service through a variety of measures including consolidation or improved coordination, increasing contract revenue for primary service providers, planning and operational improvements. The Department also serves as a transit advocate before the state legislature and U.S. Congress.

Reluctance to consolidate services was difficult to overcome in many cases. Assurances must be provided to an agency that its clients will receive at least the same level of transit service at no cost to the agency in excess of what they are currently spending. It is usually not enough, however, to demonstrate equal service for equal cost to the agency. An increases in service and/or a reduction in cost plus a plan or agreement to transfer drivers or other employees to the primary transit provider is frequently required before an agreement to consolidate can be consummated. State level attempts to consolidate administrative responsibility in order to streamline and standardize reporting and increase provider accountability require the same kind of approach outlined for local providers. The standardized reporting facilitates the collective documentation of transit efficiency and effectiveness necessary when attempting to secure additional financial support. Safety and operational standards can also be established and monitored using the report data thereby increasing the level of accountability and ensuring the best use of limited resources.

The perception of transit in rural areas or transit that targets the disadvantaged as an inefficient government giveaway was not easy to overcome in some areas. When the system is open to the public it may be best to standardize logos using the word "public", i.e. MISS. PUBLIC TRANSIT (Provided by local agency). Standardizing vehicle colors will also make them easily recognizable. Extensive local media coverage and a well executed advertising and promotional program also helped change the negative perception and pay dividends in increased general public ridership and revenues. More people using the system and lower subsidy per passsnger trip translated into more political support for the system. Although numerous concepts, techniques, and approaches to transit have been developed and used elsewhere, it has been our experience that local ledership, local flexibility, and local innovation were the real keys to successful transit for the disadvantaged in Mississippi.

Examples of Local Diversity and Innovation

One important conclusion we reached upon completing an evaluation of Mississippi's transit systems was that no standard model could be developed from empirical observations to ensure the success of a transit system. The number of significant variables that must be taken into account dictate diversity and innovation for success. Local politics, availability of financial resources, socioeconomic characteristics, institutional characteristics, transportation needs, local leadership and physical characteristics of an area are among characteristics affecting the design of an effective and efficient transit system.

The following three transit projects were influenced by different local environments, but do have some things in common consistent with state guidelines. All three projects provide services to the general public and generate as much revenue as possible to offset the cost of services while at the same time emphasizing service to a particular target group or serveral target groups. All three projects are committed to providing an essential community service and finally, all three incorporate preventative maintenance, driver training, and close monitoring of operational cost in order to maximize system efficiency.

Bolivar County Council on Aging (BCCOA)

The BCCOA is a social service agency providing the majority of its services in Bolivar County, a predominantly rural county in the Mississippi Delta area (Figure 1). The agency has provided some transportation services to the poor, elderly, and handicapped since 1975. Since becoming a Section 18 Rural Public Transit Project in 1981 the BCCOA has continued to target its service toward the elderly and handicapped. The project provides regularly scheduled service to welfare offices, shopping centers, health care and medical facilities, utility offices, meal sites and special social activities. In addition, however, the agency provides service to the general public. The expanded services are publicized and promoted, thereby enhancing the agency's image in the community. The revenues generated from serving general public needs (mainly work trips) make it possible to provide a better level of service to the transportation disadvantaged.

Through creative and innovative management the project has generated substantial contract revenues. Much of this revenue is a result of providing service to employees of the state prison in the area three times a day at $45 per month and Sunday service in the prison compound to prison visitors at $1.00 per person. Revenues more than offset the cost of providing services enabling the project to provide more service to the transportation disadvantaged and enhancing its image which facilitates efforts to get increased funding from local government when necessary.

Fifty nine percent of the project's operating costs are paid by contract and fare revenues and an average of 1,976 passenger trips are made each month.

Mississippi Valley State University (MVSU)

Mississippi Valley State University is a coeducational unit situated in what is traditionally defined as the Mississippi Delta, an area of agriculture concentration. The University transit service area is composed of nine counties (Figure 1).

Since 1958 the University has provided limited transportation for students and employees. In 1982 M.V.S.U. became a Section 18 Rural Public Transit Project and has continued serving students and employees, with improved services, as its target clients. The University, of course made a committment to community service providing transit to the general public including transportation of the disadvantaged.

Administration of the program is beyond the traditional approach in that such administration is under the auspices of the Continuing Education Program of the University. Direct supervision and internal project evaluation is provided by the Assistant Director who reports to the Director of Continuing Education, who is responsible to the University President.

The project offers a pass book discount to University and general public riders. Fixed-route, fixed-schedule services are provided between residential areas in the region and the University in the mornings and between the University and residential areas in the region in the afternoons. The routes are designed to provide service to and from mental health centers and other social services.

The system is operated in a professional manner benefiting the nine county service area and the University. Since there is a shortage of student housing on the University campus, the transit system makes the University more accessible to potential students in the region and according to University officials is responsible for some of the increased enrollment experienced each year since the service began. The services are also an attractive amenity for University employees and the school's image is enhanced due to the services provided to the general public and transportation disadvantaged in the area. Additional service is made available to the state prison similar to that used by the Bolivar County Council on Aging.

As of June 1984, forty three percent of the project's operating costs are paid by contract and fare revenues and an average of 8,334 passenger trips are made monthly.

Mississippi Band of Choctaws

The Mississippi Choctaw Indian Transit Project serves three counties in east central Mississippi (Figure 1). Although the Choctaws have been providing some transit services for several years it was not until 1981 that the Mississippi Band of Choctaws became a Section 18 Rural Public Transportation Project.

The Choctaws have been in a period of employment transition in recent years with the creation of a moderate industrial park creating more nonagricultural employment opportunities. Much of the Choctaw Transit System emphasis is on meeting work trip demand in the three county area through the provision of the fixed-route, fixed-schedule service between industrial complexes and residential areas. Services are, of course, provided to the general public. Some routes serve the Choctaw High School and services are provided to the transportation disadvantaged.

The Band of Choctaws Tribal Council established a Choctaw Transit Authority to operate and coordinate transportation services. The Authority is governed by a Board of Commissioners appointed by the Tribal Chief. The Authority is required to submit an annual report to the Council and Chief describing its operations and financial condition.

Consolidation of transit service responsibility has resulted in expanded service at less cost per unit of service. The project constructed its own maintenance facility and fueling station. Maintenance and repair services are provided for a fee to private as well as public vehicles.

Ninety-seven percent of the project's operating costs are paid by contract and fare revenues and an average of 1900 passenger trips are served each month.

Conclusion

In Mississippi, as evidence shows, there was need for a unified approach to transit for the elderly, handicapped, and other transportation disadvantaged. As a poor state with few "traditional" public transit systems, the transit needs of the elderly and handicapped may be better met whenever unification becomes reality.

The Section 18 Program has given state and local governments a mechanism for enhancing transit efficiency through broad based flexible transportation operations in providing transit services to the rural transportation disadvantaged.

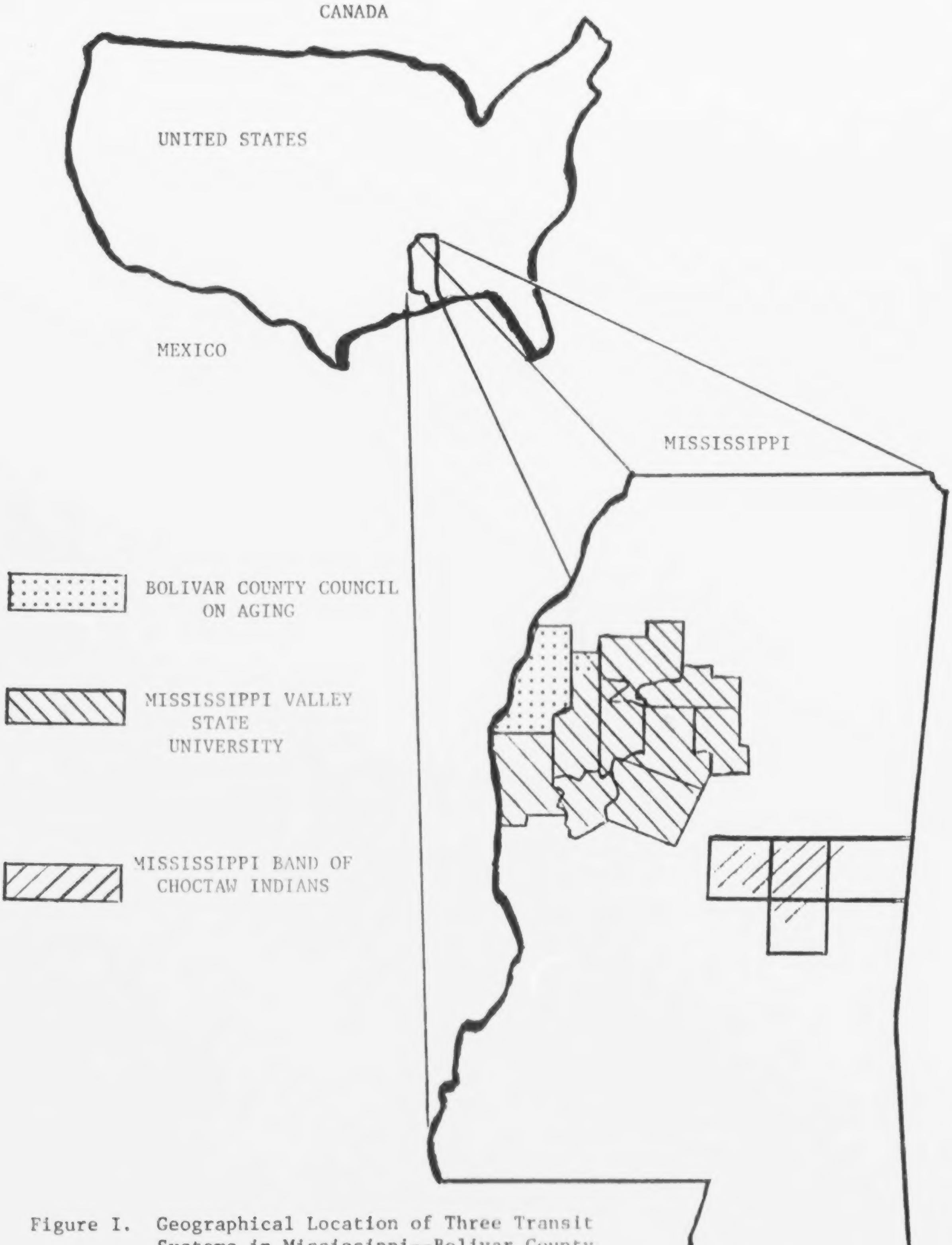

CANADA
UNITED STATES
MEXICO
MISSISSIPPI
BOLIVAR COUNTY COUNCIL ON AGING
MISSISSIPPI VALLEY STATE UNIVERSITY
MISSISSIPPI BAND OF CHOCTAW INDIANS

Figure I. Geographical Location of Three Transit Systems in Mississippi--Bolivar County Council on Aging, Mississippi Valley State University and Mississippi Band of Choctaw Indians.

Greater local flexibility in the use of funds seems desirable with the state more actively assisting in integrating efforts. Such integrating efforts could include transportation brokerage, determing priorities, assisting in cooperative ventures, pooling financial services, and providing technical assistance inproject development. Underlying all these areas of assistance is the desire to give local providers some freedom in their initiatives so that, as much as possible, the system remains "theirs".

J. Fred Wise, Transportation Manager, Mississippi Department of Energy and Transportation, Jackson, Mississippi; J. William Rush, Professor of Transportation, Mississippi State University, State College, Mississippi.

VEHICLE OWNERSHIP AND DRIVING BEHAVIOUR OF SENIORS IN CANADA

Robert A. Wolfe

Introduction

Very little is understood in Canada regarding the driving activities of seniors, and even less is known about their vehicle ownership patterns. This situation may be characteristic of other countries who share a lack of data on the topic. When so little is known, it becomes difficult to plan for any form of transportation services, because authorities are unable to adequately describe the senior population in terms of their transportation needs and requirements.

A recent survey of a sample of Canadians (including seniors) was undertaken in order to be able to mathematically model vehicle ownership and usage for the general population. As a consequence, a rich data set was made available and the activities of seniors could be compared to those of the rest of the non-senior population. Specific data that were available included demographic information, access to transportation, vehicle ownership by type and quantity of vehicle, and a count of vehicle kilometers driven for work and non-work purposes during a one week period.

This paper will detail the tabulated findings related to this data set, but no econometric modelling will be reported, largely due to the complex nature of modelling results. For further information on the modelling results using the entire data set, refer to Berkowitz et. al (1984).

A Description of the Data Set

The data set was collected as part of a large project funded by Energy, Mines and Resources Canada in an attempt to be able to predict gasoline consumption on a reliable basis. This has been the subject of a great deal of research, but in Canada no appropriate data were available for the modelling efforts. The data collection procedures were designed by a team at the University of Toronto-York University Joint Program as reported in Wolfe et. al (1984). The following points regarding the data collection are pertinent to this paper:

a) The data were collected on a national basis, excluding the Province of Newfoundland and the Northwest and Yukon Territories. The geographic omissions were due to a lack of data collection support in these regions.

b) The data were collected through a self-administered mail-back survey which included sections on household demographics, vehicle ownership and usage for all vehicles in the household, and vehicle kilometers travelled for each vehicle for every day in a one week period in November 1982.

c) Respondents were selected by a survey consultant and all belonged to a panel of individuals maintained by the consultant. No bias was generated by this sample selection procedure, as no attitudinal data were requested, and great efforts were extended to ensure lack of socio-demographic bias across a number of dimensions. The results were subjected to a detailed comparison to the 1981 Census of Canada and exceptionally positive results were reported in Wolfe et. al (1984).

d) Of the 2400 surveys mailed out, 1977 were returned and 1306 contained all of the required data.

These data are the subject of analysis in this article. It must be recognized that the data were collected for a purpose other than that being presented here. As a consequence, the number of senior analyzed is small, but some information is better than none at all.

Demographic Analysis of Seniors in the Sample

Of all 3009 persons reported in the sample, 448 (or 14.9 percent) were aged 65 and older. Of the seniors, 41.7 percent were male and 58.3 percent female, and 94.6 percent were heads of household either alone or with a spouse. Figure 1 depicts these data as well as a general age/sex pyramid for the population of respondents.

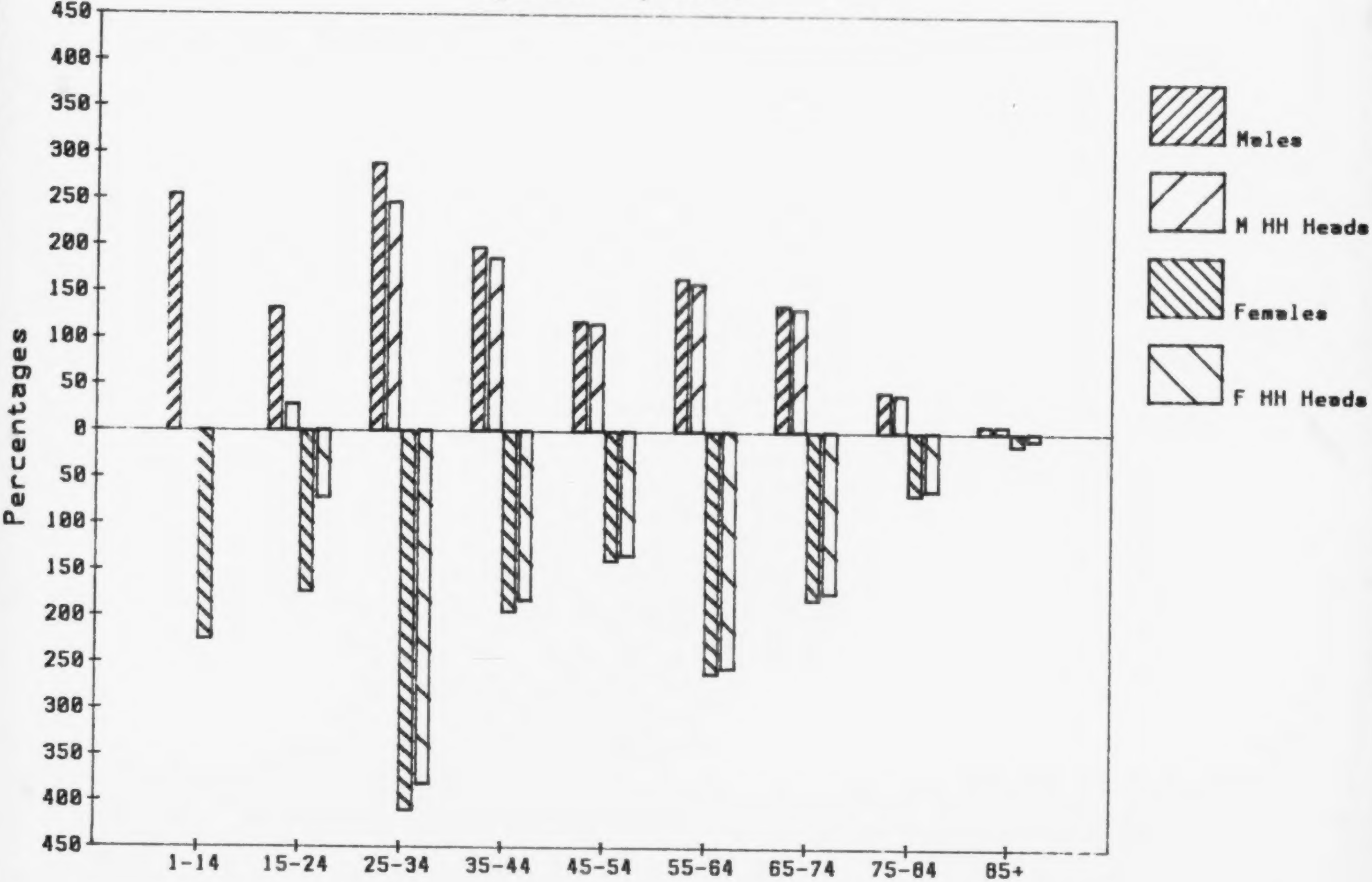
Figure 2 depicts vehicle ownership by age group and household income category for the entire population. Ownership levels above two vehicles were not included due to the lack of observations of this nature. It is evident that the highest number of zero vehicle households is in the senior population. Also shown is the general lower income levels of seniors (a mean of $14,900 versus $23,200 for the general population). Very few seniors own two vehicles, and few own one vehicle, but most of those who own a vehicle are of low income. Roughly the same number of senior-headed household own vehicles as those who own none.

Figure 3 depicts household tenure type by age of household head. It is clear that the proportion of home owners to home renters does not drop with age of the household head, at least until very advanced age. Figure 4 shows the dwelling types that households live in, again by age of household head. Here it is clear that the proportion of households that live in apartments increases

4C0

FIGURE 1

Age/Sex Pyramid



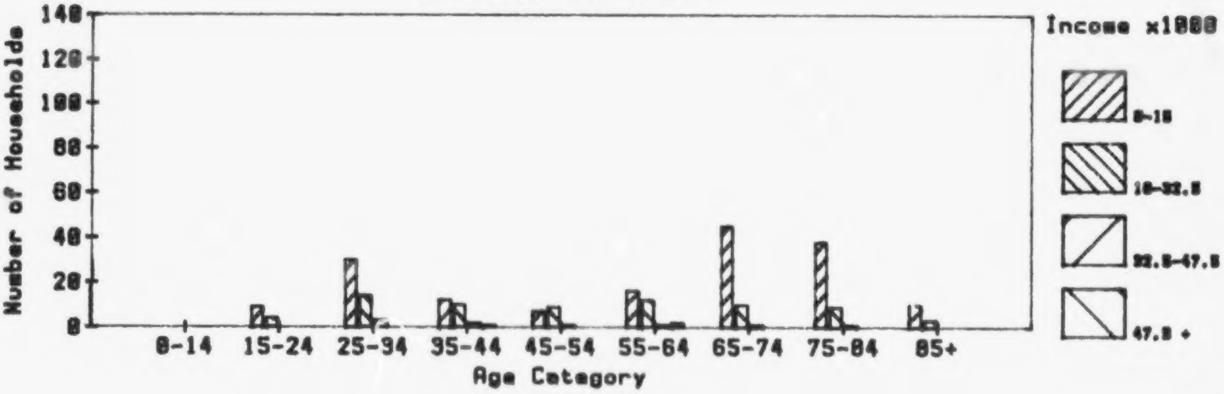
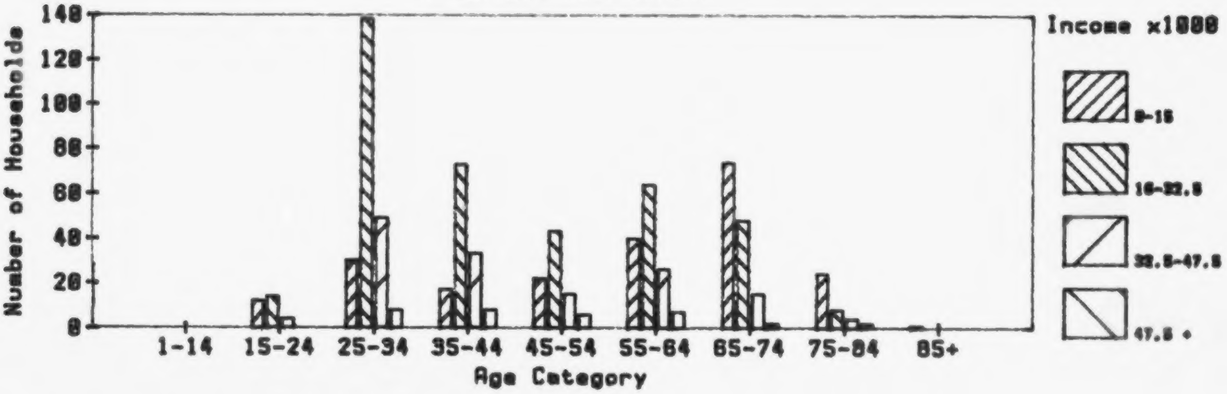
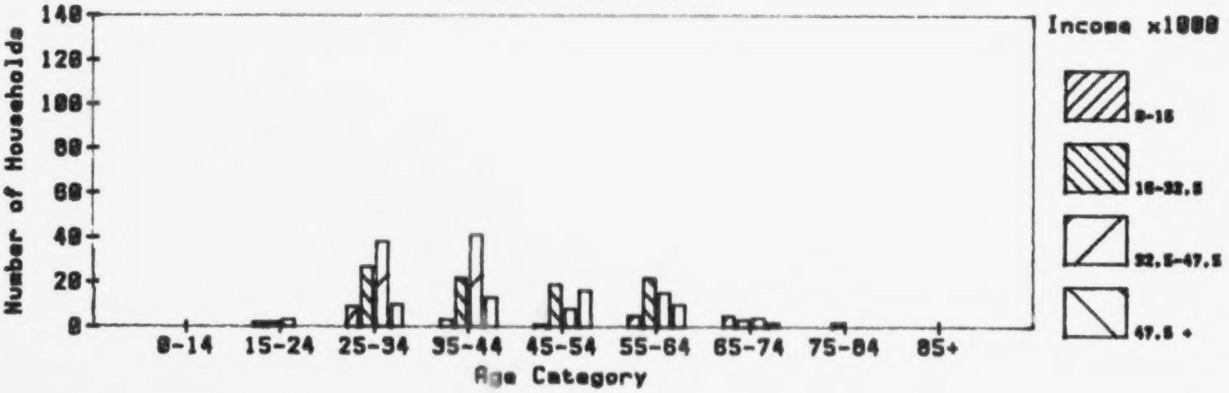


FIGURE 2
Vehicles by Age and Income
0 Vehicle Households



1 Vehicle Households



2 Vehicle Households

FIGURE 3
Tenure by Age of Head

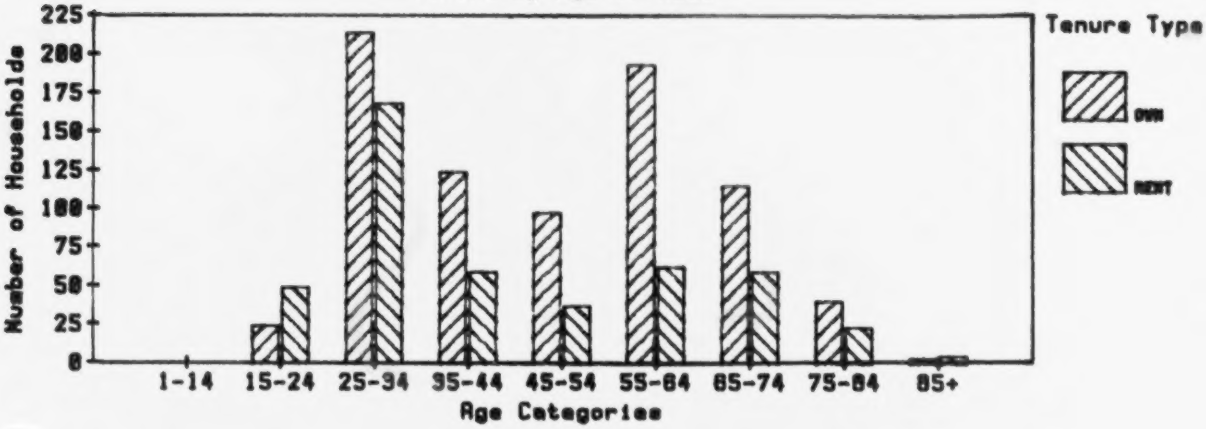


FIGURE 4
Dwelling Types by Age of Head

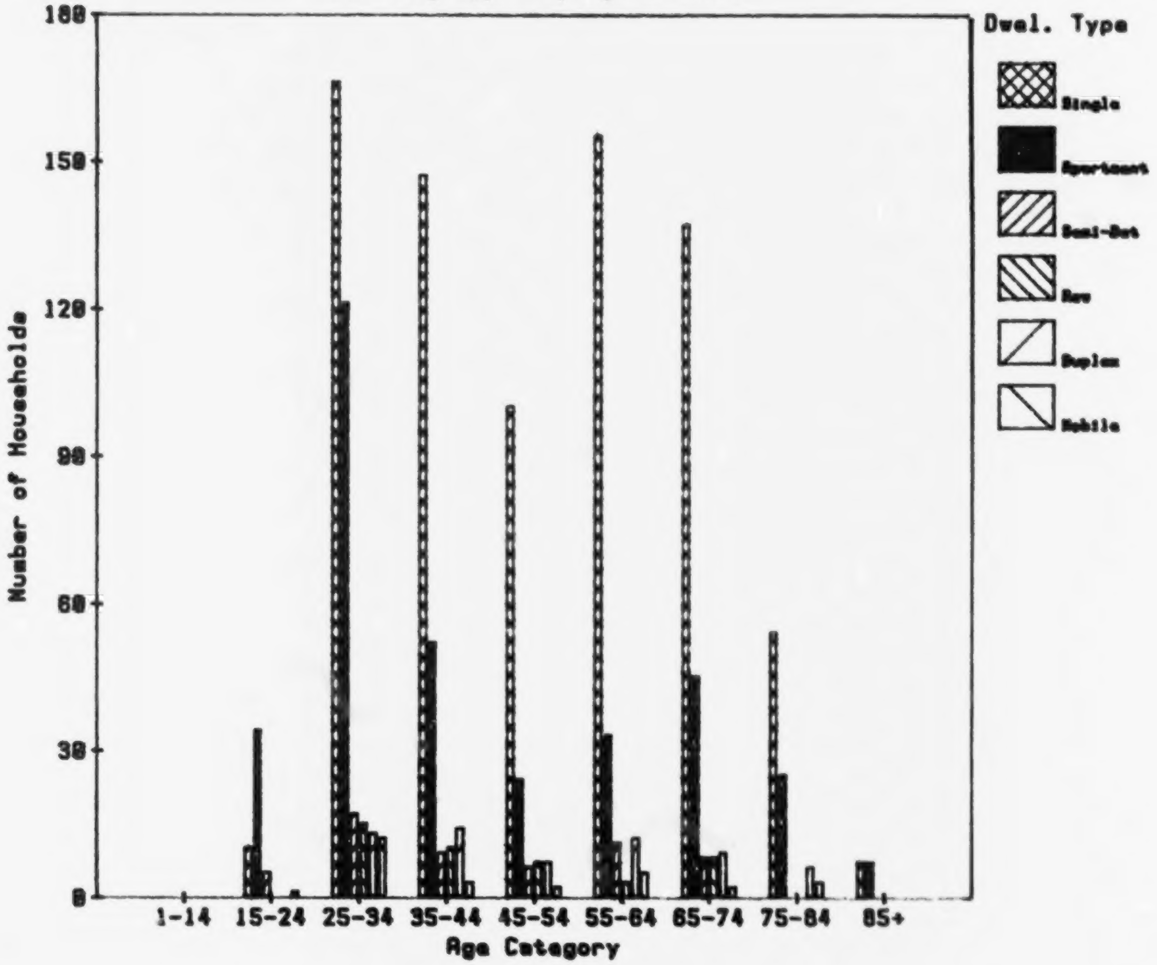


FIGURE 5
Employment Status by Age of Head

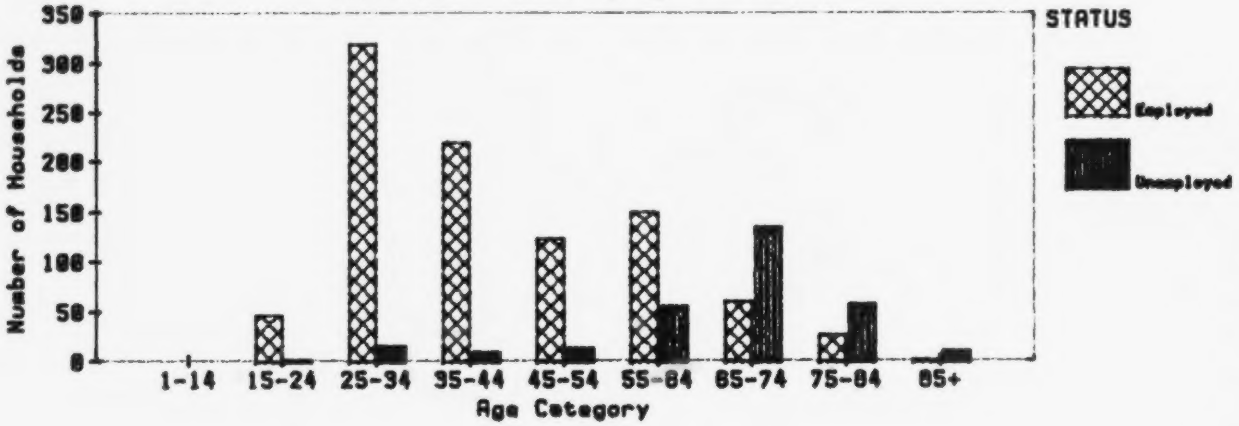
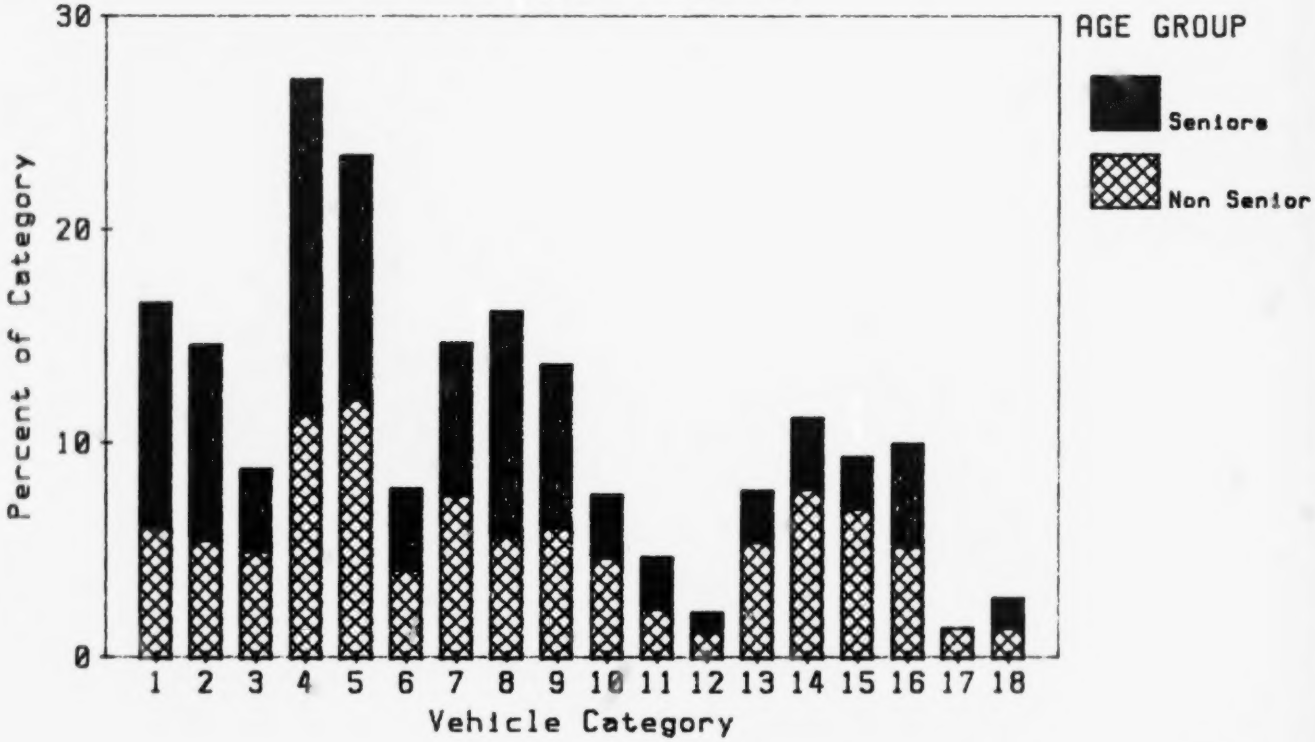


FIGURE 6
Vehicle Type Categories



as the age of the household head increases. In fact the proportion is almost 1 to 1 for the most aged household category.

Finally, Figure 5 shows employment status by age of the household head. It appears that about one third of the senior household heads aged 65-84 are employed and most others are retired or unemployed. Of those employed, about half are professional or white collar workers, and about half are blue collar workers.

From this brief demographic analysis, it is evident that the senior population depicted in this survey is somewhat typical of North American elderly populations. Some seniors work, most own homes, and only about half own vehicles. In the next two sections, the vehicle ownership and useage behaviour of this population will be examined.

Vehicle Ownership Information

It is generally assumed that seniors drive older, inefficient vehicles due to household budgetary constraints. A further problem is that these vehicles are more expensive to maintain and because of their age, break down more frequently. These specific hypotheses were examined in detail and, in general, no evidence was found to firmly support any of the hypothesis.

Of the 1337 vehicles owned by households in the sample, 210 were owned by households headed by persons aged 65 years and older. Cluster analysis was used to divide the vehicles into eighteen type/vintage categories for purposes of this analysis (and the later modelling efforts not reported in this paper). The categories are presented in Table 1 and were developed with the objective of obtaining several groups which were "somewhat" homogeneous with respect to fuel consumption and vehicle size.

In Figure 6, it can be seen that the percent of older, large cars is only slightly higher for seniors than for the non-senior population. Seniors do own substantially fewer foreign made vehicles, fewer trucks and no sports cars. Otherwise, popular categories are medium sized, newer vintage vehicles. In Figure 7 it further apparent that seniors hold only a slightly large proportion of high fuel consuming vehicles. They do own a smaller proportion of highly efficient cars, but this could be accounted by the lower percentage of foreign cars owned by seniors.

Detailed examination of the data therefore shows that vehicles held by seniors are similarly distributed for the non-senior population. This was an unexpected results and could not be immediately explained. One possible reason is that due to the harshness of Canadian winters, older unreliable cars do not do well in this weather, and it might be possible that seniors opt to spend their vehicle budget on purchasing reliable cars rather than maintaining older ones. In addition, due to the widespread use of road salt, vehicles do not last long and rust rapidly.

TABLE 1

Vehicle Classification Categories

Number	*Description*	
1	Medium Domestic Sedans	1974 and earlier
2	Large Domestic Sedans	1974 and earlier
3	Small Domestic Sedans	1975-79
4	Medium Domestic Sedans	1975-79
5	Large Domestic Sedans	1975-79
6	Small Domestic Sedans	1980 and newer
7	Medium Domestic Sedans	1980 and newer
8	Large Domestic Sedans	1980 and newer
9	Medium Domestic Wagons	
10	Large Domestic Wagons	
11	Foreign Wagons	
12	Volvos	
13	Very Small Foreign	
14	Small Foreign	
15	Medium Trucks	
16	Large Trucks	
17	Sports Cars	
18	Luxury Cars	

In any event it appears that seniors who own vehicles spend a large portion of their income on their vehicles, probably a proportion higher than expended by the non-senior population. Unfortunately data were not available to substantiate this hypothesis, but Figure 2 does show that seniors who own vehicles have lower incomes than the rest of the population. If they spend part of that income on similar auto purchases, than they may be spending a larger proportion of their income on this item.

Vehicle Use Behavior

One might expect that seniors drive less than the rest of the population, since few seniors commute to work and usually do not have the travel demands created by transporting dependents in the family. This was found to be the case, but not by a large extent. It can be seen in Figure 8 that the relative proportion of people driving between 100 to 400 kilometers per week is lower for senior headed households. Curiously, though, there is evidence of several high mileage households among the senior group.

Further analysis was conducted to determine if the availability of public transit within ¼ mile (that is within walking distance) had any effect on kilometers traveled. The results shown in Figure 9 are very unusual in that they show that households travel more where public transit is available. It appears that a much higher percentage of seniors have low vehicle usage per week, but more in areas with access to transit than without such transit. This

FIGURE 7

Age of Head vs MPG

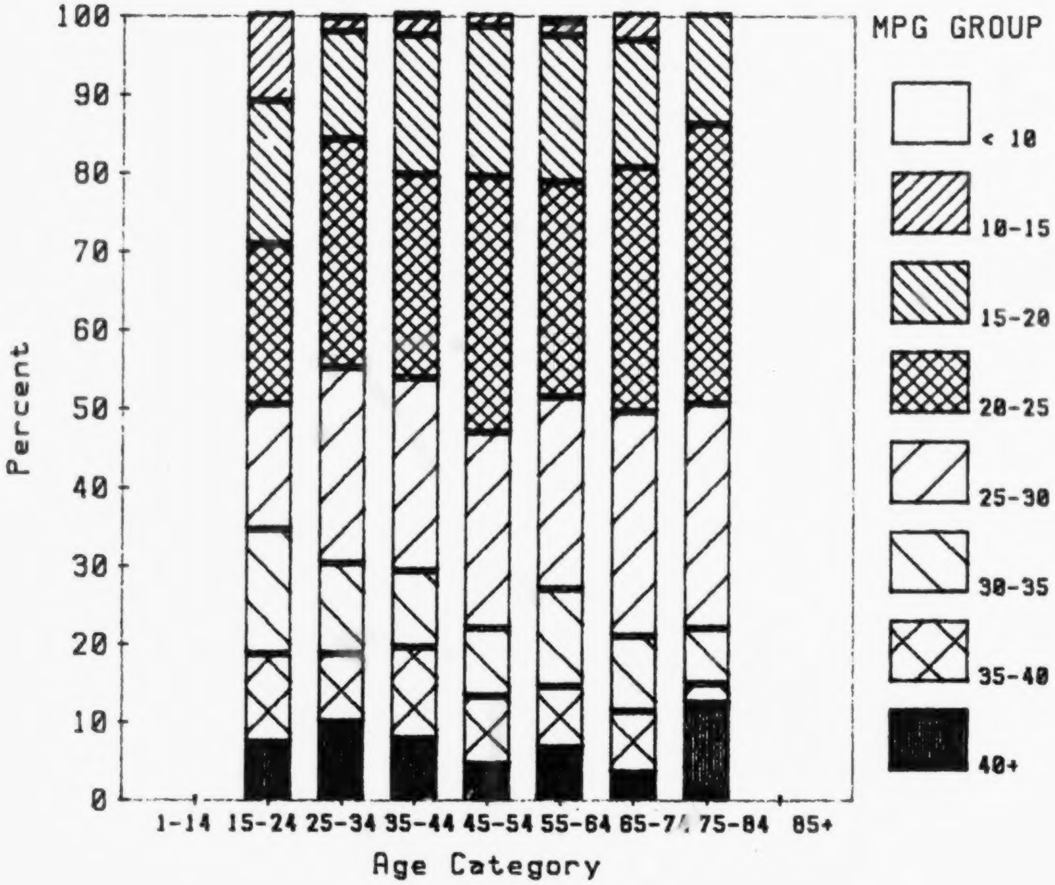


FIGURE 8

Vehicle Kilometers Travelled

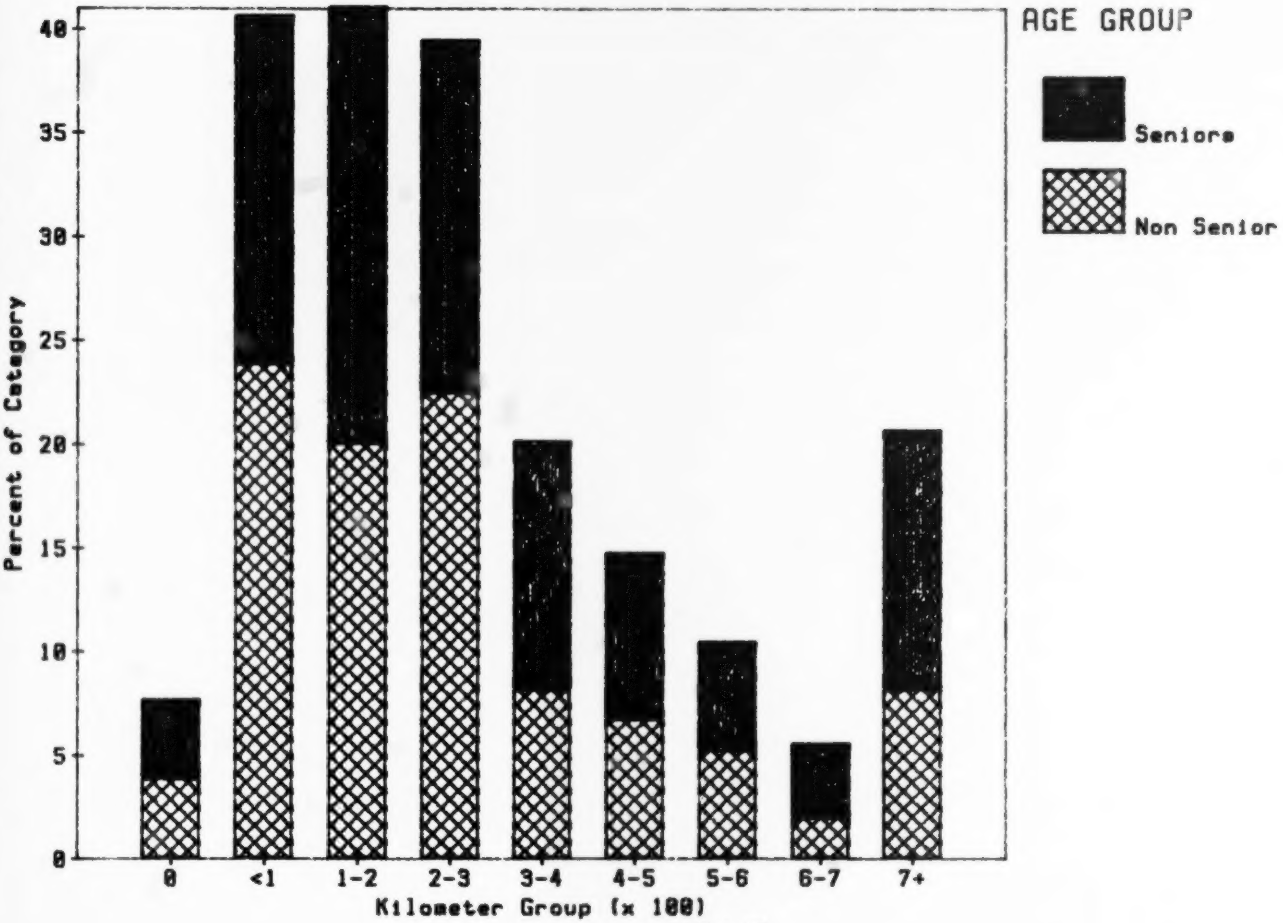
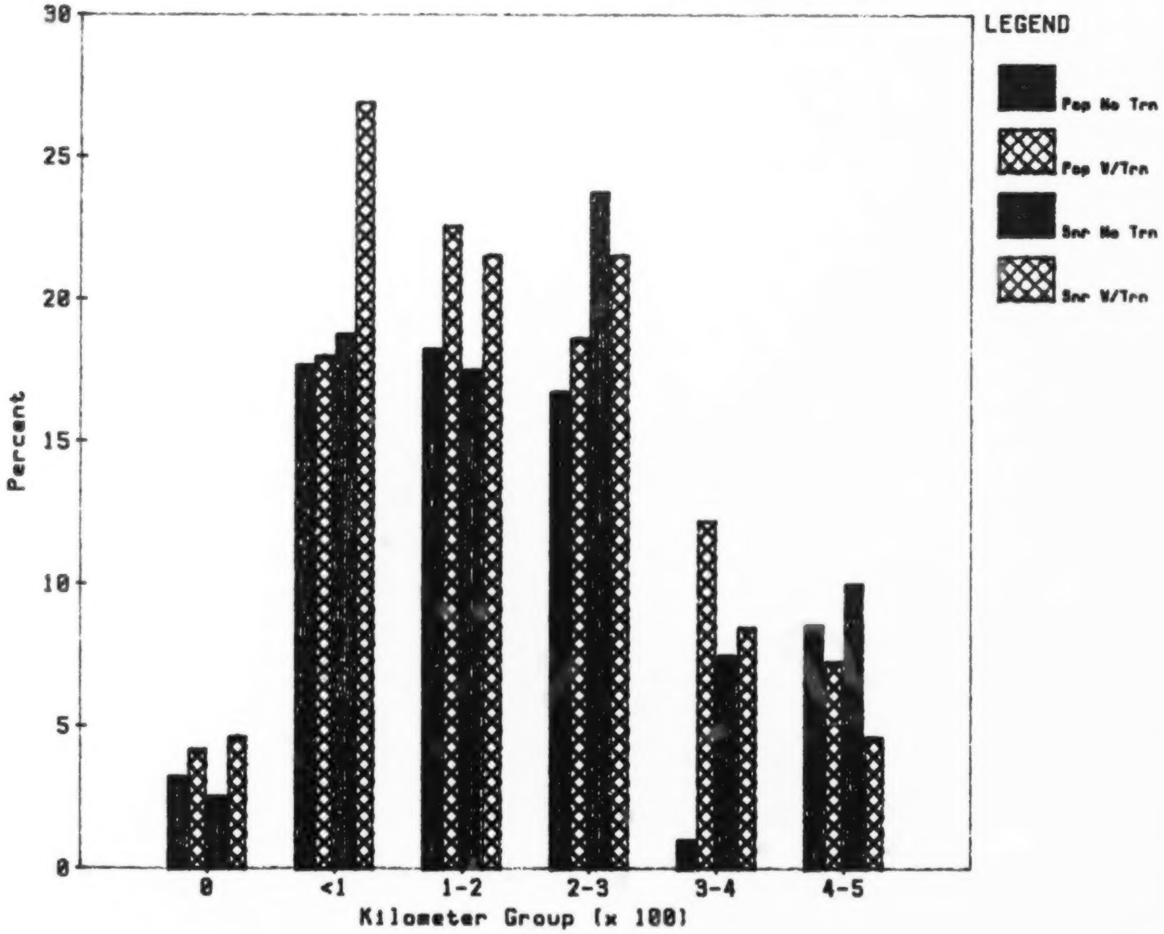


FIGURE 9

Vehicle Km. and Transit Availability



may be explained by the fact that good access to public transit is only provided in large cities and travel distances are greater in larger than in smaller cities. This hypothesis could be proven with data not shown here.

In general, it was found that seniors do travel slightly less than the non-senior population, but not by a large amount.

Conclusions and Summary

In this brief analysis, it has been shown that the driving behaviour of the senior population in Canada is not very different from the non-senior population. Differences are small, and it can be concluded that seniors who own vehicles may spend a great deal to retain them, use them actively and are quite mobile. This supports the often-stated point that seniors who do not have access to a car or public transit are highly deprived of their mobility and have significant travel requirements that are not met by any means. Quite clearly a senior household with a vehicle is not a member of this deprived group.

References

Berkowitz, M., N. Gallini, E.J. Miller and R.A. Wolfe "Disaggregate Modelling of Vehicle Ownership and Use", submitted to the Transportation Research Board, 1984.

Wolfe, R.A., N. Gallini, E.J. Miller, M., Berkowitz and R. Ridout, "Vehicle Ownership and Usage in Canada: Data Issues and Collection. Transportation Forum, Forthcoming, September 1984.

Robert A. Wolfe, Research Director, Viscount Innovations, Toronto Ontario, Canada M6A 3A1; and Department of Economics, Scarborough College, University of Toronto, Toronto, Ontario, Canada.

7

The Global Village

TRANSPORTATION OF ELDERLY AND HANDICAPPED PERSONS: THE RIGHT TO MOBILITY IN THE GLOBAL VILLAGE

Janice J. Tait

The notion that concepts of equality and strategies of equality seekers can be kept within the largely artificial boundaries of modern states denies . . . the realities of contemporary means of communication and transportation . . .''—Jill Vickers[1]

Introduction

It is the thesis of this paper that states which are developing internal policies for the transportation of elderly and disabled persons need to consider the broader problem of the movement of disabled travellers between countries. As real incomes grow, transportation facilities improve and expectations rise, trips for business and pleasure will increase in the ''global village.'' In this regard, the International Bill of Human Rights of the United Nations provides a framework for thinking about how travel can be made less discriminatory on a transnational basis and about how to promote reasonable access to facilities and services customarily available to the general public.

This paper will first outline recent and current initiatives to define and protect the rights of elderly and handicapped persons on both the international and Canadian scene and then examine several problem areas that must be addressed when considering transportation for elderly and handicapped persons between countries. Some of the particular difficulties faced by the disabled traveller at the international level will be discussed. Finally, certain problems of particular relevance in the urban transit field will be addressed in the context of their international implications.

International Human Rights Framework

Before identifying the specific human rights framework within which disabled persons are operating, at both the international and the national level, it is necessary to point out what exactly is being sought by physically and mentally handicapped persons. Discrimination against disabled persons has for many groups been seen from a new perspective since the International Year of Disabled Persons in 1981. In the case of some physically disabled persons, exclusion from full participation and equality is primarily based on the limitations of the built environment. For this group, our response to these environmental obstacles must be to change the way we construct our world so that disabled persons can move about more easily. This is also true for many of the frail elderly. However, for mentally handicapped persons, the obstacles to full participation and equality are more subtle and less evident. For example, for this group communication difficulties may take longer to resolve. Nevertheless, some service providers have recognized their positive duty to serve this segment of the public in a safe and equitable way.

Early thinking on human rights revolved around the notion of fair play—that is, people should be given an equal opportunity with others to approach the starting-gate in the so-called race of life. This meant some general level of basic necessities such as food, shelter, clothing, education, freedom of expression, should be protected and upheld by laws of the state. At the international level, these requirements were written into the Universal Declaration of Human Rights, the International Covenant on Civil and Political Rights and the Optional Protocol.

However, many people realized that the notion of fair play, while necessary to protect human rights, was not precise enough because it did not safeguard the right to equal opportunity. Evidently some of those who presented themselves at the starting gate were still handicapped such as women, the elderly, ethnic minorities, physically and mentally disabled persons. The concept of fair shares or equality of conditions gradually emerged which then led to the realization that in order to provide equality of opportunity, some catching-up measures would have to be put in place.[2] Thus a range of measures associated with the concepts of affirmative action, reasonable accommodation, and bona fide occupational requirements, have been developed to deal with the more deeply-rooted aspects of discrimination, which in spite of legislative intent, still holds many back from full participation and equality.

These measures, designed to ensure that people have a reasonable amount of whatever goods society produces and a fair chance in the race of life, are reflected in a number of initiatives at the international level. For example, the International Covenant on Economic, Social and Cultural Rights, which was ratified by 35 member states of the United Nations in January, 1976. Article 2 of this Covenant commits States Parties to "take steps, individually and through international assistance and cooperation, . . . to achieving progressively the full realization of (the) rights . . ." Article 15.1(b) recognizes the right of everyone "To enjoy the benefits of scientific progress and its applications." States agree to submit regular reports on their progress towards achieving economic, social and cultural rights and these reports are transmitted to the Economic and Social Council for consideration (Article 16). The Economic and Social Council may transmit reports to the Commission on Human Rights for study and general recommendation (Article 19), and international action for the achievement of rights by such methods as the conclusion of conventions or the adoption of resolutions (Article 23).

---

[1] Jill McCalla Vickers, ''New Perspectives on the Concept of Equality, Take Care!'' Discussion paper on Human Rights Protection and Advocacy in Canada, Human Rights Coalition, Ottawa, October, 1983, p. 16. I have drawn heavily on the Vickers paper for some of the ideas expressed in this paper.

[2] For an excellent discussion of the concepts of ''fair play'' and ''fair shares'' see William Ryan, Equality, (New York: Pantheon Books, 1981).

The Economic and Social Council, in conjunction with the U.N. Commission on Human Rights, has been active in establishing recognition of the status and claims of disabled persons. Resolutions in the 1970's affirmed the inclusion of physically and mentally disabled persons under the Universal Declaration. In 1982, the General Assembly adopted the World Programme of Action Concerning Disabled Persons and declared 1983-92 the United Nations Decade of Disabled Persons. Countries are expected to develop and report on national plans in support of the World Programme of Action. Recently, the Sub-Commission on the Prevention of Discrimination and the Protection of Minorities agreed to hire a rapporteur to look into the problems of human rights for disabled persons and to report in 1986.

Canadian Human Rights Framework

In addition to these international measures designed to give weight and substance to the protection of individual human rights at the global level, nation states such as Sweden, France, Canada and West Germany have also undertaken to protect disabled persons against discrimination in employment and access to facilities and services. In Canada, for example, the Canadian Charter of Rights and Freedoms was proclaimed in April, 1982. The Equality Rights section (S.15) of the Charter comes into effect in April, 1985 and disabled persons are protected . . . ". . . before and under the law" and have "the right to the equal protection and equal benefit of the law . . ." The Charter is the "supreme law of the Constitution" (S.52) and applies to "all matters within the authority of Parliament . . . (and) of the legislature of each province . . ." (S.32). Parliament or the legislature of a province may override a human rights provision of the Charter but only for five years (S.33).

In addition to the Charter which applied to relationships between governments and individuals, the ten provinces, two territories and the federal government each have a human rights code which generally protects disabled persons in employment and access to facilities and services.

The Canadian Human Rights Act (CHRA) was recently amended in July, 1983 to extend the grounds of protection to mentally handicapped persons and to extend the grounds of protection to physically and mentally handicapped persons in gaining access to facilities and services. Provisions are also made for the passage of regulations pursuant to the CHRA setting out accessibility standards in relation to facilities and services. Service providers can also submit an adaptation plan to the Canadian Human Rights Commission (CHRC), which, if accepted, would provide immunity from complaint for items covered under the plan. The federal government, and in particular Transport Canada, is now in the process of developing accessibility standards for transportation modes under federal jurisdiction—air, intercity passenger rail, intercity bus in Newfoundland and East Coast ferries.

It is useful to draw attention to a few of the recent initiatives taken by Transport Canada:

a) Intercity Bus. A federal/provincial bus working group is currently developing guidelines leading to standards for interprovincial bus services and the intercity Roadcruiser bus service in Newfoundland.

b) *Air.* Transport Canada is examining the operational feasibility of the concept of "self-determination of self-reliance" of disabled travellers. This concept states that disabled people themselves are the best judge of their capacity to cope with the problems of air travel and that limitations on that travel can be imposed only under strict criteria. For example, the requirement for passenger attendants could be limited to assistance with physical needs in flight. The need for assistance in evacuation of the aircraft in the event of an emergency could be covered by limiting the numbers of unaccompanied, non-ambulatory passengers per flight, in accordance with approved Transport Canada safety guidelines.

Other accessibility standards to consider could require air carriers to provide equivalent levels of service throughout Canada in all planes carrying more than 60 passengers. These include such services as advanced seat booking, transportation of wet-cell batteries in specially designed containers, and provision of communications aids and information to blind and deaf passengers. These standards could apply to Canadian carriers in foreign countries and to foreign carriers with landing rights in Canada. However, the effectiveness of the consideration and development of accessibility standards could be enhanced by the establishment of an international convention on accessibility standards for the transportation of disabled passengers by commercial air carriers.

c) *Rail.* Passenger rail services are a federal responsibility. The national passenger rail service, VIA Rail, has already begun installing station-based lifts at 19 railway stations. The Railway Transport Committee of the Canadian Transport Commission is developing accessibility standards for passenger rail. In addition, a feasibility study on commuter rail services is underway to determine what level of access might be provided to people in wheelchairs, particularly for the journey-to-work.

d) *Multi-modal Travel.* A multi-modal travel card is under consideration by the federal government which would allow disabled passengers, who require attendants to assist them on a trip, to apply to the Canadian Transport Commission for such a card. With the card, attendants would then be carried at a reduced fare or no cost on all transportation modes under federal jurisdiction. (This fare reduction for attendants already applies on all rail, intercity bus and ferry services).

Problem Areas

a) Air. Currently the International Air Transport Association (IATA) has a set of guidelines for air travel for disabled persons which were adopted in 1981. These guidelines are voluntary, however, and IATA, as a carrier association, has no power to enforce them. This means that disabled persons can never be sure that they will be able to complete an air journey to a foreign country in safety and with dignity. Although the IATA guidelines have helped smooth the way for disabled travellers, there have been complaints that there is too much leeway for individual interpretation of the rules, particularly regarding the difficult issue of self-reliance. One recommendation to resolve this is that the International Civil Aviation Organization (ICAO) investigate the possibility of developing an international convention on accessibility for the transportation of disabled persons by commercial air carriers to be presented to the Economic and Social Council by December, 1986.

b) *Reciprocity.* The provision of access to facilities and services to disabled persons in the urban transportatio area has been the subject of considerable agonized international debate. Different states are dealing with this issue in different ways but policy questions remain unanswered. Central is the issue of "integrated" versus "separate" services. Integrated services are costly in the short term but may become cost effective over the longer time frame. Some mix of integrated and separate services would likely provide the best compromise. The U.S. and Sweden are working towards this goal. Other states opt for "separate but equal" transportation services which oftan turn out to be considerably less than equal. Separate, parallel, door-to-door services may appear to be less costly in the short term but, as trip demand increases, experience shows their efficiency and response levels begin to drop. Eligibility criteria are often narrowed to restrain demand which only frustrates potential users whose expectations have been raised. Some governments attempt to deal with rising demand by encouraging volunteer services. While this too may be a useful interim measure, it does not appear to constitute a long term solution. Equity will require that paratransit services, if they remain separate, be put on a footing at least comparable with those of public transit. In the long run, separate services are likely to remain unequal and pressure will continue for integration in urban transportation services.

From the perspective of mobility in the global village for elderly and disabled persons, there remains another issue: global reciprocity in access to paratransit services. Able-bodied people can ride a public transit service anywhere in the world for the price of a fare; disabled persons, at the present time, are usually confined to access to the paratransit service in the place where they live and are registered. The principles of equity and full participation would seem to require that disabled persons be extended the same access to paratransit services as are now enjoyed by able-bodied persons, between cities, provinces and states. What good is it if one is in an electric wheelchair and one flies to London, Paris, Rome, or Washington, if one cannot use a taxi and the paratransit service is not extended to include the disabled? If disabled persons are to enjoy the benefits of scientific progress and its applications under Article 15.1(b) of the International Covenant on Economic, Social and Cultural Rights, then gradual extension of access to paratransit services for all disabled travellers throughout the world is a desirable goal. Perhaps the Economic and Social Council of the United Nations could undertake a study of how this might be achieved as part of the World Programme of Action Concerning Disabled Persons.

c) *Car Rentals.* Similar to the problem of obtaining access to paratransit services, the lack of quick-release hand controls for cars which can be rented at airports is another inequitable limitation on mobility for disabled travellers. Since quick-release hand controls, which allow disabled persons to drive, are available in most western countries, another goal could be to see that these technical aids are available, on 24-hour notice at all international terminals with car rental services.

d) *International Vehicle Identification.* To facilitate access to special parking places for disabled drivers or drivers of disabled persons, global reciprocity is required in accepting vehicle identification signs or symbols. Usually, some form of the international wheelchair symbol is used. Much work has already been done by Canada's federal and provincial Ministers of Transport to develop a Memorandum of Understanding agreeing to accept the vehicle identification symbols of each province as evidence of bona fide right to use a special parking place. This will mean that able-bodied drivers who park in these special areas and do not display the symbol can be ticketed. For Canada, the next step could be to achieve reciprocity with the United States. European states have already developed some measure of reciprocity. In the future there's hope that some way can be found so that disabled drivers may obtain a special travel card (perhaps with the international driver's license) to allow access to special parking places everywhere.

Disabled Persons and the Concept of Equality.

It is difficult for those who are not physically or mentally disabled to imagine what it is like to live in a world where limitations on a physical or mental capacity to perform certain functions considered "normal" can effectively bar a person from taking part in social activity. The problems of bringing disabled people into the mainstream of society are numerous, complex and bewildering, both for planners who wish to help, and for disabled persons themselves who are still trying to cope. An enlarged washroom cubicle to accommodate those in wheelchairs is useless if a four-inch step is at the entrance to the cubicle. One would laugh except that four-inch steps are an environmental barrier of insurmountable magnitude to a person in a wheelchair.

Environmental barriers are not the only problem for disabled people, or even the most intractable. Attitudes, sometimes deeply-rooted, towards people who are perceived as "different" (and even some who are not so obviously different such as deaf people or people with learning disabilities) remain as great, or even a greater barrier to acceptance in educational institutions, the job market, the leisure field, on transportation modes and in housing complexes. Unexpressed fear or disgust of body deformity, a sense of helplessness in the presence of a blind person or of frustration in trying to communicate with a deaf or mentally handicapped person, can lead to thoughtless, unkind or discriminatory behavior on the part of people who might, if they had been more aware, react in a less hostile manner.

Progress has been made in changing the physical environment to make it more accessible to physically disabled persons. However, this area presents only one of the major challenges for those who believe that the goal of full participation and equality must be extended to disabled persons. Improving attitudes towards disabled people will take longer. But it is clear that, until disabled persons can move safely, freely and confidently among us, both nationally and internationally, true integration will not be achieved.

At the time this paper was prepared, Janice J. Tait was Director, Transportation of Handicapped Program, Transport Canada, Tower C, Place de Ville, Ottawa, Ontario, K1A ON5, Canada.

☆U.S. GOVERNMENT PRINTING OFFICE: 1 9 8 6 - 4 9 1 - 8 1 0 / 2 0 7 2 2

NOTICE

This document is disseminated under the sponsorship of the Department of Transportation in the interest of information exchange. The United States Government assumes no liability for its contents or use thereof.

This report is being distributed through the U.S. Department of Transportation's Technology Sharing Program.

DOT-I-85-07

DOT-I-85-07

TECHNOLOGY SHARING

A PROGRAM OF THE U.S. DEPARTMENT OF TRANSPORTATION

416